United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
Missouri Agricultural
Experiment Station

Soil Survey of Grundy County, Missouri

How To Use This Soil Survey

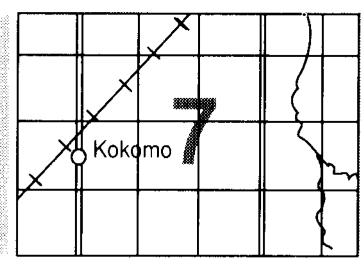
General Soil Map

The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

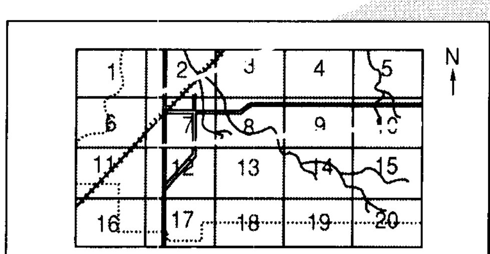
Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.



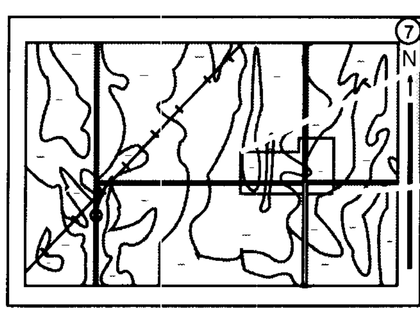
MAP SHEET

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



INDEX TO MAP SHEETS

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



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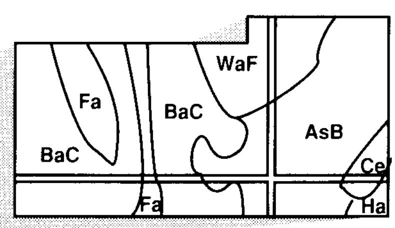

AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1982-87. Soil names and descriptions were approved in 1988. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1987. This survey was made cooperatively by the Soil Conservation Service and the Missouri Agricultural Experiment Station. It is part of the technical assistance furnished to the Grundy County Soil and Water Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

All programs and services of the Soil Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: Grass-legume hay on Lamoni clay loam, 5 to 9 percent slopes, eroded.

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Issued July 1990

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Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Grundy County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow over bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Russell C. Mills
State Conservationist
Soil Conservation Service

Soil Survey of Grundy County, Missouri

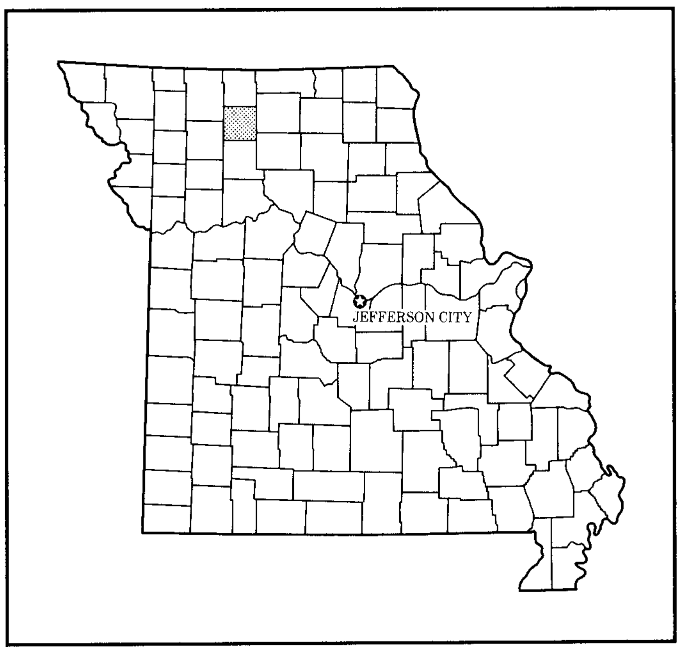
By William R. Pauls, Soil Conservation Service

Fieldwork by William R. Pauls, Clayton E. Lee, Raleigh L. Redman, Jeff A. Lamb, and Patricia A. Holdman, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service,
in cooperation with
the Missouri Agricultural Experiment Station

GRUNDY COUNTY is in north-central Missouri (fig. 1). It has a total area of 279,891 acres, or about 437 square miles. Trenton is the county seat.

This soil survey updates the survey of Grundy County published in 1916 *(11)*. It provides additional information, larger maps, and more detailed interpretive information about the soils.



General Nature of the County

This section gives general information concerning the county. It describes climate; water supply; physiography, relief, and drainage; history and development; and farming.

Climate

Prepared by the National Climatic Data Center, Asheville, North Carolina.

The consistent pattern of climate in Grundy County is one of cold winters and long, hot summers. Heavy rains occur mainly in spring and early summer. The annual rainfall is normally adequate for corn, soybeans, and all grain crops.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Trenton, Missouri, in the period 1951 to 1984. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 28 degrees F, and the average daily minimum temperature is 18 degrees. The lowest temperature on record, which occurred at Trenton on January 15, 1979, is -25 degrees. In summer the average temperature is 75 degrees, and the average daily maximum temperature is 87 degrees. The highest recorded temperature, which occurred at Trenton on July 14, 1954, is 110 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 34.79 inches. Of this, nearly 24 inches, or about 70 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 20 inches. The heaviest 1-day rainfall during the period of record was 5.61 inches at Trenton on September 18, 1978. Thunderstorms occur on about 53 days each year.

The average seasonal snowfall is about 19 inches. The greatest snow depth at any one time during the period of record was 29 inches. On the average, 16 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the south-southeast. Average windspeed is highest, 13 miles per hour, in spring.

Tornadoes and severe thunderstorms occur occasionally but are local in extent and of short duration. Damage varies and is spotty. Hailstorms occur during the warmer part of the year but in an irregular pattern and only in small areas.

Water Supply

Water supplies, which are ample for domestic needs, are available in three-fourths of Grundy County. Yields from domestic wells seldom exceed 15 gallons per minute. Irrigation wells can be developed on approximately 40,000 acres in the county. If properly developed, they can yield 200 to 1,000 gallons per minute. Domestic wells are developed for household and general farm use. Irrigation wells, or high-yield wells, provide water not only for irrigation but also for cities and industries *(8)*.

The preglacial and interglacial stream valleys that were filled with sand and gravel are good sources of water. These areas no longer conform to the present drainage patterns; however, test drilling can show their location. Areas where sand and gravel were not deposited or where the deposit of glacial drift is thin or does not occur are less favorable. Water from unconsolidated glacial drift is high in total iron, dissolved solids, and sulfates. Iron may cause staining of plumbing fixtures and laundry; however, water treatment minimizes this problem.

Water from the consolidated rock formation that underlies the county generally is highly mineralized. The mineral content increases with the depth of the well. Wells drilled to a moderate depth into consolidated rock may yield a limited amount of water that is of marginal quality.

The larger streams in the county are used as water sources for cities. Quality is good; however, in droughty years volumes are inadequate for both municipal use and irrigation. In most areas in the uplands, ponds and small lakes can supply water for household purposes and livestock.

Physiography, Relief, and Drainage

Grundy County is one of the 11 counties in Missouri that are in the Green Hills Region. The topography is mainly upland plains with gently sloping to steep hills. The two principal rivers are the Thompson and the Weldon. They have formed flood plains ½ mile to 3 miles wide. The Thompson River runs north to south and joins the Weldon River northwest of Trenton. The smaller streams in the county are Sugar Creek, Muddy Creek, Honey Creek, No Creek, and Medicine Creek. They have formed flood plains ½ mile to 2 miles wide.

Two preglacial valleys were formed in Grundy County. One is in the northwestern part of the county, and the other is in the northeastern part. The two join northeast of Trenton *(8)*.

Elevations range from 1,000 feet above sea level in the northeast corner of the county to 740 feet in an area along the Thompson River south of Trenton.

History and Development

The first settler in what is now Grundy County was Brigadier General William Preston Thompson. He arrived in 1833. The first settlement was 5 miles north of Edinburg in an area along Thompson Fork, which is a branch of the Grand River. Pioneers started settling near what is now Trenton in 1835. These early settlers emigrated from Virginia, Kentucky, Tennessee, and Ohio. Most of the immigration took place between 1836

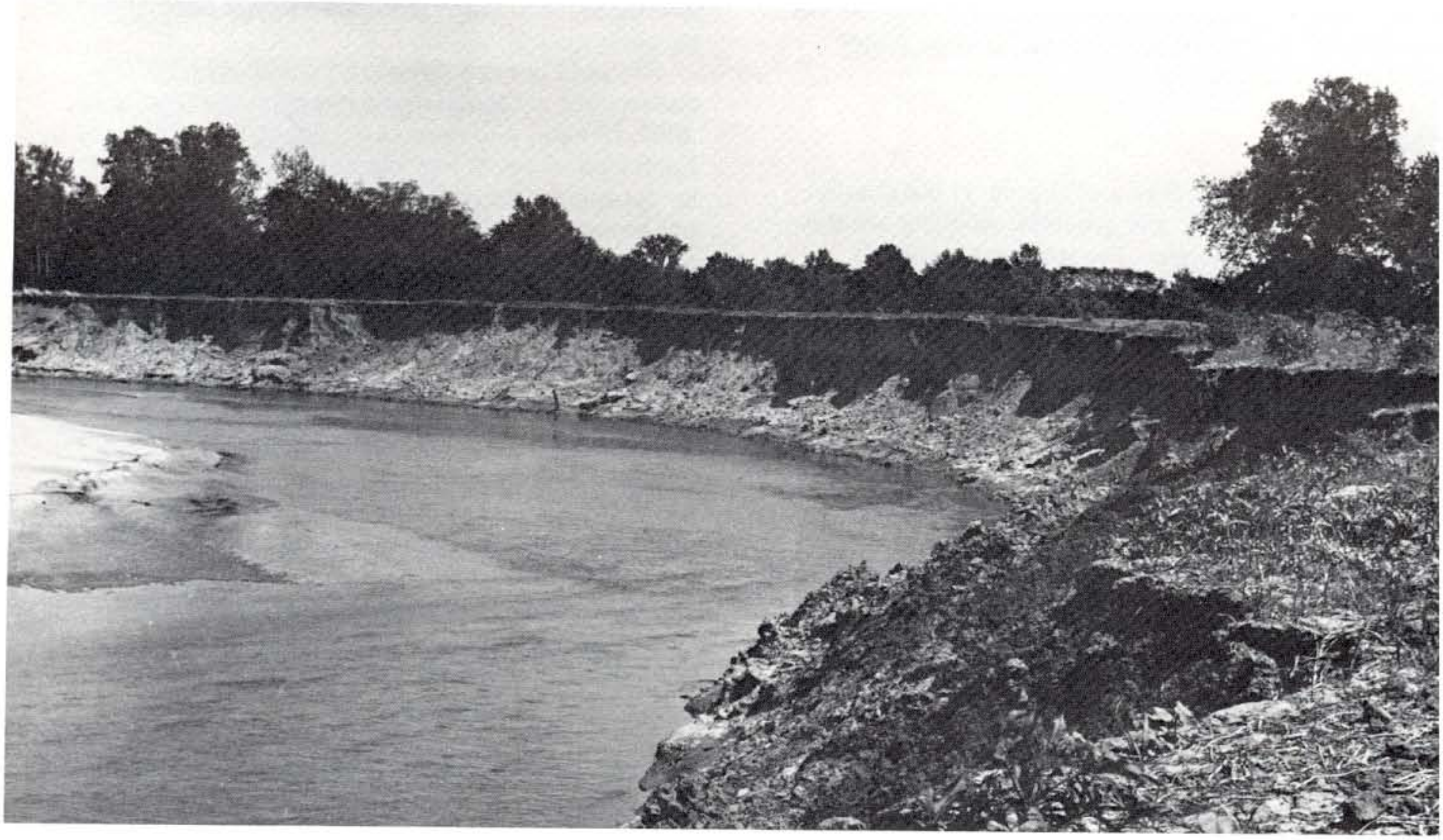


Figure 2.—Severe streambank erosion in an area of Nodaway silt loam along the Weldon River.

and 1838. Mormons were also some of the first pioneers, settling in what is now Franklin Township.

Grundy County was surveyed from 1836 to 1837; however, it was not organized as a county until January of 1841. It was named after Felix Grundy, the United States Attorney General under President Andrew Jackson. The county seat was established in 1841 at Bluff Grove, also known as Lomak Store, now known as Trenton *(5)*.

The population of Grundy County was at a peak of 17,832 in 1900 *(15)*. It decreased steadily to 11,525 between 1900 and 1983. In 1984, it was 11,633 *(4)*.

During early settlement, river travel was the most practical way to move a family. The westward route was down the Ohio River to the Mississippi, then to the Missouri, and then up the Grand River to the Thompson River.

Agriculture has always been the major economic enterprise in Grundy County. Settlers in the 1800's grew row crops. Large areas of native prairies supplied ample amounts of hay and pasture for livestock. Wildlife was plentiful and was a year-round source of meat. Because of a favorable growing season, ample rainfall, and productive soils, the survey area produced abundant crops and livestock.

By the 1900's, there was a growing desire to increase the extent of cultivated areas. Streambank erosion and the constantly meandering streams were destroying valuable farmland. Drainage districts were organized in 1919 to reduce the hazard of flooding and to improve the suitability of bottom land for crops. By the 1920's, channels were dug in all of the major rivers and streams. The districts were dissolved between 1943 and 1954, however, and no organized maintenance has been done since that time. Currently severe streambank erosion and new meanders are rapidly increasing in extent (fig. 2).

Concern shifted to upland conservation in the early 1930's. The first terraces were built in 1931, and farming on the contour was first implemented in 1938. Plans for a soil and water conservation district began in 1954; however, it was not until May of 1967 that the

State Soil and Water District Commission certified the organization of the Grundy County Soil and Water Conservation District *(6)*.

Farming

Agriculture is the primary enterprise in the county. Cash crops, livestock, and livestock products are the major sources of income. The principal crops are soybeans, winter wheat, corn, sorghum, legumes, and grasses. Livestock enterprises produce hogs, beef cattle, dairy cattle, sheep, and poultry.

The general trend since 1930 has been toward fewer and larger farms and an increase in the use of fertilizers, chemicals, and larger machinery. The number of farms steadily decreased from 2,298 in 1900 to 740 in 1982. The size of the farms increased from an average of about 118 acres in 1900 to 332 in 1982. Ownership has also changed. In 1900, about 51 percent of the farms were operated by full-time farmers, 16 percent by part-time farmers, and 33 percent by tenants. In 1982, about 60 percent of the farms were operated by full-time farmers, 31 percent by part-time farmers, and 9 percent by tenants *(7)*.

Land use has changed in Grundy County. In 1930, about 47.5 percent of the county was cropland, 36.0 percent was pasture, and 1.0 percent was woodland. In 1982, about 65 percent was cropland, 25 percent was pasture, and 5 percent was woodland. In that year crops were harvested on about 160,200 acres. About 55 percent of this acreage was used for soybeans, 13 percent for wheat, 9 percent for corn, and 3 percent for sorghum. About 20 percent was harvested for hay *(7)*. Of the total farm income in 1982, about 58 percent was from crops and 42 percent was from the sale of livestock and livestock products *(7)*.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, soil reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management.

Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are named and mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The descriptions, names, and delineations of the soils identified on the general soil map of this county do not fully agree with those of the soils identified on the maps of adjacent counties published at a different date. Differences are the result of additional soil data, variations in the intensity of mapping, and correlation decisions that reflect local conditions. In some areas combining small acreages of similar soils that respond to use and management in much the same way is more practical than mapping these soils separately.

Soil Descriptions

1. Lamoni-Shelby-Grundy Association

Deep, gently sloping to moderately steep, moderately well drained and somewhat poorly drained soils formed in loess and glacial till; on uplands

This association consists of soils on narrow to wide ridgetops, short to long side slopes, and high stream terraces. It makes up about 44 percent of the county. It is about 47 percent Lamoni and similar soils, 23 percent Shelby and similar soils, 19 percent Grundy and similar soils, and 11 percent minor soils (fig. 3).

Lamoni soils are moderately sloping and are somewhat poorly drained. They are on side slopes and narrow ridgetops. Typically, the surface layer is very dark gray, friable loam and clay loam. The subsurface layer is very dark grayish brown, friable clay loam. The subsoil is mottled clay. The upper part is dark grayish brown and firm, the next part is grayish brown and very firm, and the lower part is gray and firm.

Shelby soils are strongly sloping and moderately steep and are moderately well drained. They are on side slopes. Typically, the surface layer is black, friable loam and clay loam. The subsurface layer is very dark brown, friable clay loam. The subsoil and the substratum are firm clay loam. The upper part of the subsoil is dark brown and brown. The lower part of the subsoil and the substratum are yellowish brown and mottled.

Grundy soils are gently sloping and are somewhat poorly drained. They are on narrow to wide ridgetops and the upper side slopes and on high stream terraces. Typically, the surface layer is black, friable silt loam and silty clay loam. The subsurface layer is mixed black and very dark gray, friable silt loam. The subsoil is mottled and firm. The upper part is dark grayish brown silty clay loam, the next part is dark grayish brown silty clay, and the lower part is grayish brown silty clay loam. The substratum is grayish brown, mottled, firm silty clay loam.

Minor in this association are the Colo and Fatima soils on narrow flood plains. Colo soils are poorly drained. Fatima soils are silty throughout.

Most areas of this association are used for cultivated crops, hay, or pasture. Some scattered areas are wooded. These areas are principally in draws and along fence rows. The soils on most of the ridgetops, on the upper side slopes, and on some of the lower side slopes are suited to corn, soybeans, grain sorghum, and small grain. The slope and the hazard of water erosion are the main concerns in managing cropland. The hazard of water erosion and overgrazing are the

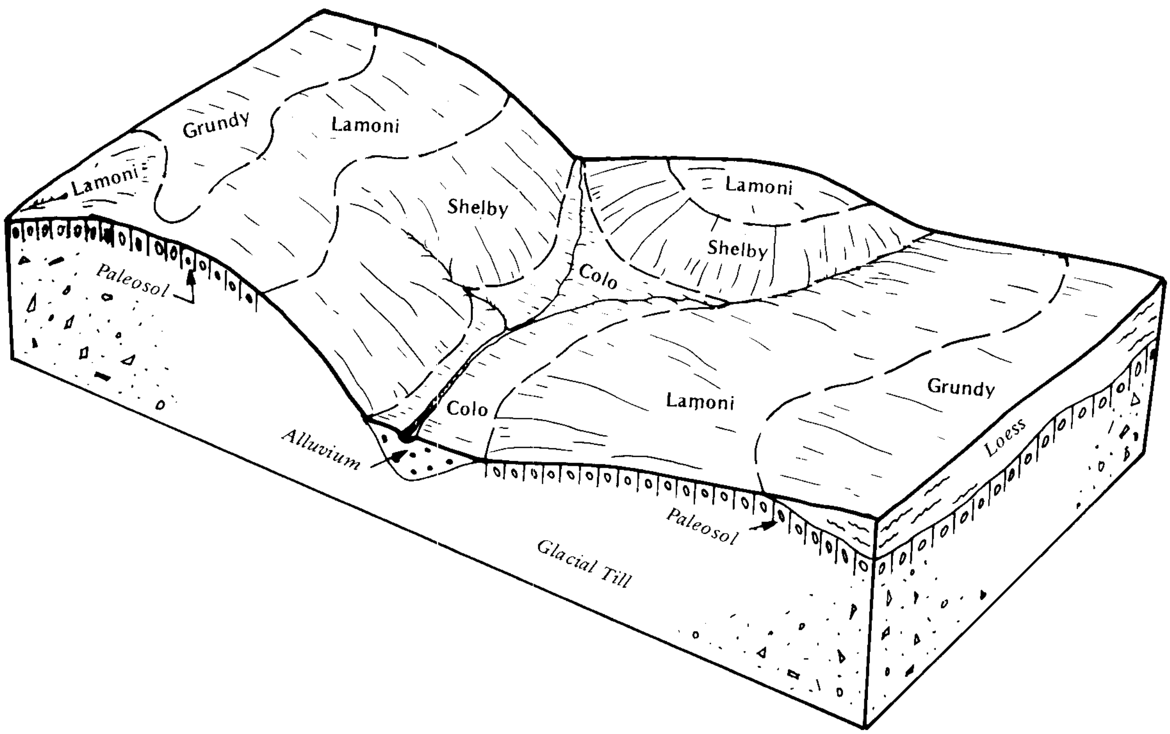


Figure 3.—Pattern of soils and parent material in the Lamoni-Shelby-Grundy association.

major concerns in managing pasture. In most pastured areas ponds have been constructed to provide water for livestock.

The major soils are suited to building site development and sanitary facilities. The shrink-swell potential, the slope, and restricted permeability in areas of all the major soils and the wetness of the Lamoni and Grundy soils are limitations affecting one or both of those uses.

2. Zook-Nodaway-Wabash Association

Deep, nearly level, poorly drained, moderately well drained, and very poorly drained soils formed in alluvium; on flood plains

This association consists of soils on medium and large flood plains. It is characterized by slight changes in relief, or differences in elevation of only a few feet. In most areas the streams have been channelized, leaving abandoned channels, some of which have been reclaimed for agricultural uses. In most areas cultivated fields are directly adjacent to the new channels. Some areas have meandering stream channels bordered by woodland, pasture, or cropland.

This association makes up about 26 percent of the county. It is about 36 percent Zook and similar soils, 31 percent Nodaway and similar soils, 15 percent Wabash soils, and 18 percent minor soils (fig. 4).

Zook soils are nearly level and are poorly drained. They commonly are in low areas some distance from the original river or stream channels. Typically, the surface layer is black, friable silty clay loam. The subsurface layer is black, friable silty clay loam and firm silty clay. The subsoil and substratum are mottled, firm silty clay. The subsoil is very dark gray, and the substratum is dark gray.

Nodaway soils are nearly level and are moderately well drained. They are adjacent to the original river and stream channels. Typically, the surface layer and substratum are friable silt loam. The surface layer is very dark gray, and the substratum is stratified brown, grayish brown, dark grayish brown, and very dark grayish brown.

Wabash soils are nearly level or depressional and are very poorly drained. They commonly are in the lowest areas and slack-water areas some distance from the original river or stream channels. Typically, the surface layer and subsurface layer are black, firm silty clay. The subsoil is mottled, very firm silty clay. The upper part is black, and the lower part is very dark gray

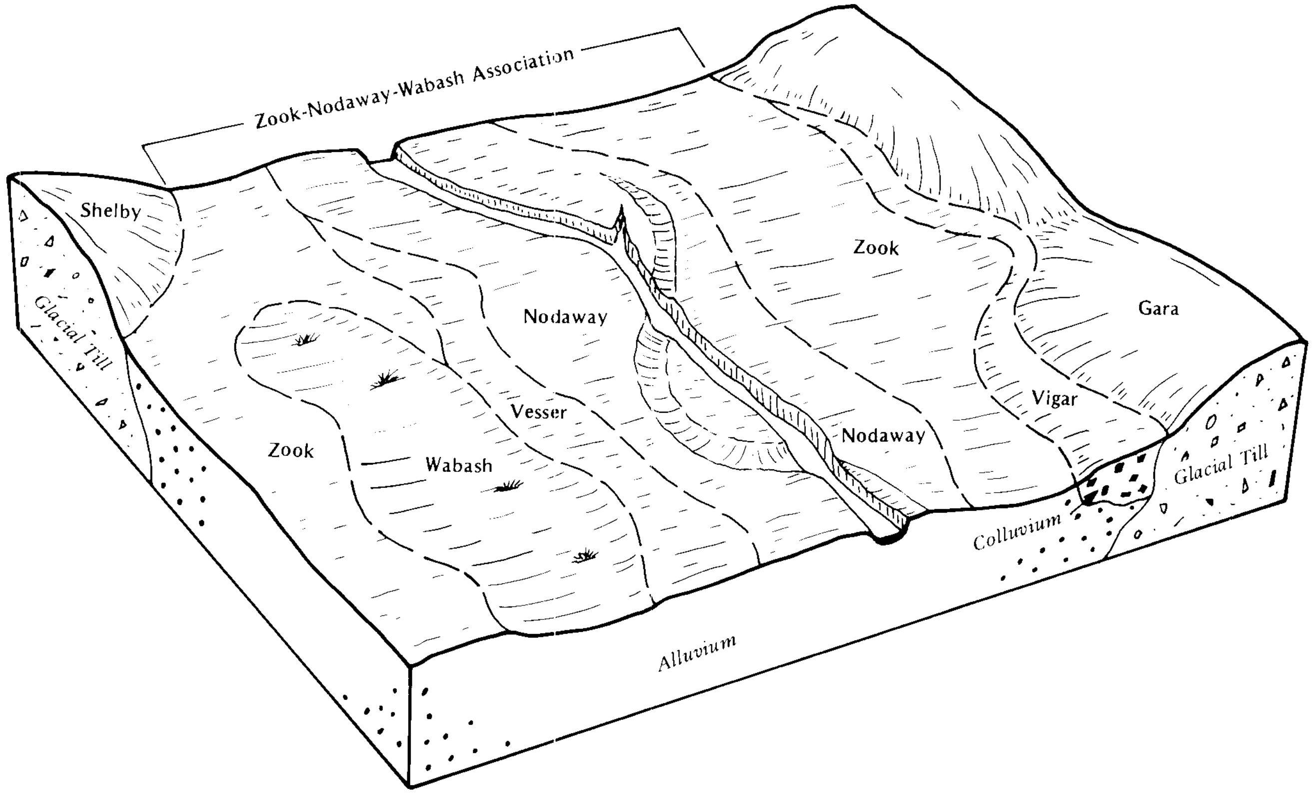


Figure 4.—Pattern of soils and parent material in the Zook-Nodaway-Wabash association.

and dark gray. The substratum is gray, mottled, firm silty clay.

Minor in this association are the Vesser and Vigar soils. The somewhat poorly drained Vesser soils are on slight rises. The moderately well drained Vigar soils are on foot slopes.

Most areas of this association are used for cultivated crops. These soils are suited to corn, soybeans, grain sorghum, and small grain. Flooding is a hazard throughout the association, and the wetness of the Zook and Wabash soils is a limitation.

The major soils generally are unsuited to building site development and sanitary facilities because of the flooding.

3. Armstrong-Gara-Vanmeter Association

Deep and moderately deep, gently sloping to very steep, somewhat poorly drained and moderately well drained soils formed in glacial till and shale residuum; on uplands

This association consists of soils on narrow ridgetops and highly dissected side slopes adjacent to the larger streams and rivers. It makes up about 30 percent of the county. It is about 41 percent Armstrong soils and similar soils, 33 percent Gara and similar soils, 10 percent Vanmeter soils, and 16 percent minor soils (fig. 5).

Armstrong soils are deep, are gently sloping and moderately sloping, and are somewhat poorly drained. They are on narrow ridgetops and the upper side slopes. Typically, the surface layer is very dark grayish brown, friable loam or clay loam. The subsurface layer is dark brown, friable loam. The subsoil is mottled and firm. The upper part is dark yellowish brown clay loam, the next part is brown and yellowish brown clay, and the lower part is strong brown clay loam. The substratum is strong brown, mottled, firm clay loam.

Gara soils are deep, are strongly sloping and moderately steep, and are moderately well drained. They are on side slopes. Typically, the surface layer is very dark grayish brown, friable loam or clay loam. The subsurface layer is brown, friable loam. The subsoil is firm clay loam. The upper part is dark brown, the next part is dark yellowish brown, and the lower part is dark

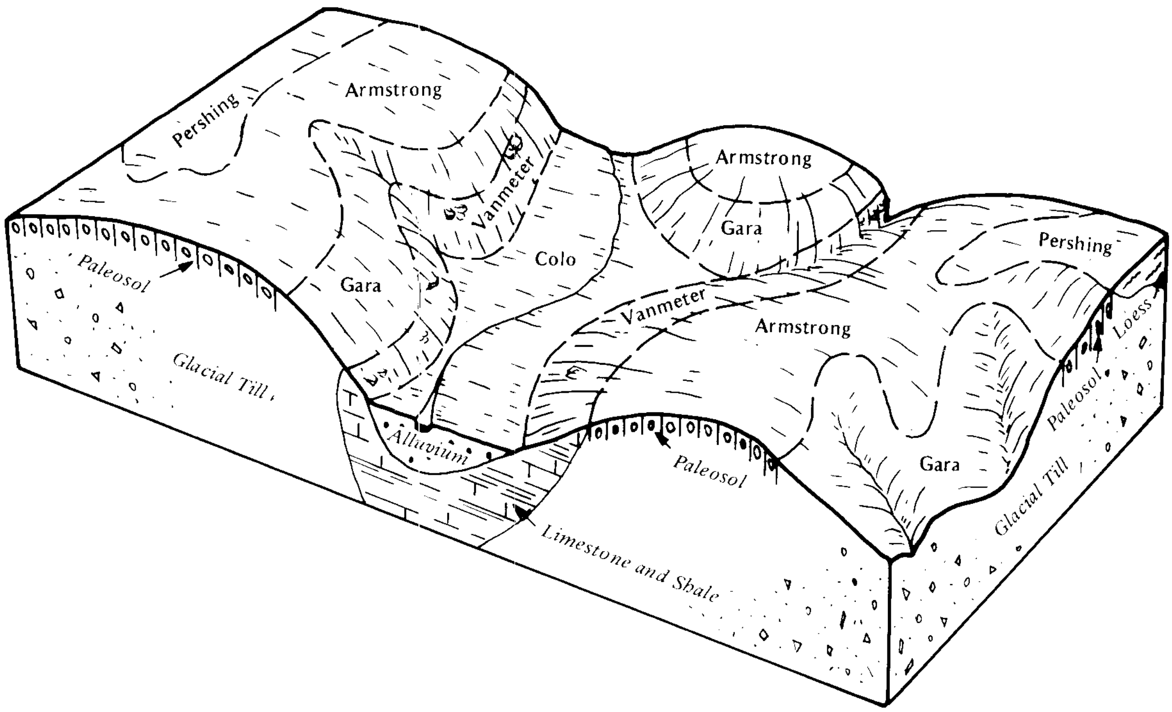


Figure 5.—Pattern of soils and parent material in the Armstrong-Gara-Vanmeter association.

yellowish brown and mottled. The substratum is yellowish brown, mottled firm clay loam.

Vanmeter soils are moderately deep, are strongly sloping to very steep, and are moderately well drained. They are on side slopes. Scattered limestone flagstones are on the surface and in the upper part of the soils. Typically, the surface layer is dark grayish brown, friable flaggy silty clay loam. The subsoil is firm silty clay. The upper part is dark grayish brown, grayish brown, and light olive brown, and the lower part is multicolored. Grayish brown and yellowish brown, weathered shale bedrock is at a depth of about 32 inches.

Minor in this association are the Colo and Pershing soils. The gently sloping, somewhat poorly drained Pershing soils are on narrow ridgetops, on high terraces, and on the upper side slopes of ridges. The poorly drained Colo soils are on narrow flood plains.

Most areas of this association are used as woodland or as wooded pasture. The soils in this association are suited to trees. The slope of the steeper Gara and Vanmeter soils and the rock fragments and outcrops in areas of the Vanmeter soils limit the use of equipment. Water erosion is a problem on the Gara and Vanmeter soils. Seedling mortality and the windthrow hazard are problems on the Armstrong and Vanmeter soils.

Some areas of this association are used for hay and pasture. Most grasses and legumes grow well. A cover of these plants is effective in controlling water erosion. In most areas ponds provide water for livestock.

Some areas of this association are used for crops. The soils on most ridgetops, on the upper side slopes, and in a few areas of narrow bottom land are suited to corn, soybeans, grain sorghum, and small grain. Controlling erosion and improving or maintaining fertility and tilth are the main problems in managing cropland.

The Vanmeter soils generally are unsuited to building site development and sanitary facilities because of seepage, the slope, the depth to bedrock, and the shrink-swell potential. Gara and Armstrong soils are suited to those uses. The shrink-swell potential, slope, and restricted permeability of the Armstrong and Gara soils and the wetness of the Armstrong soils are limitations affecting one or both of those uses.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Grundy silty clay loam, 2 to 5 percent slopes, eroded, is a phase of the Grundy series.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, quarries, is an example. Miscellaneous areas are shown on the soil maps.

The descriptions, names, and delineations of soils identified on the detailed soil maps of this county do not fully agree with those of the soils identified on the maps of adjacent counties published at a different date. Differences are the result of additional soil data, variations in the intensity of mapping, and correlation decisions that reflect local conditions. In some areas combining small acreages of similar soils that respond to use and management in much the same way is more practical than mapping these soils separately.

Table 4 gives the acreages and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

03B—Kilwinning silt loam, 2 to 5 percent slopes. This gently sloping, poorly drained soil is on ridgetops in the uplands. Individual areas are irregular in shape and range from about 5 to more than 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 8 inches thick. The subsoil extends to a depth of 60 inches or more. It is mottled and firm. The upper part is dark grayish brown silty clay loam and silty clay, and the lower part is grayish brown silty clay or silty clay loam. In some areas the subsoil has more sand and small pebbles. In other areas the surface layer is silty clay loam. In a few places the subsoil has less clay.

Permeability is very slow. Surface runoff is medium. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The surface layer is friable and can be easily tilled within a moderate range in moisture content. The shrink-swell potential of the subsoil is high. A perched water table is at a depth of 1 to 2 feet during most winter and spring months.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain. Water erosion is a hazard if the soil is used for cultivated crops. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Some areas are smooth enough and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration. Wetness sometimes delays fieldwork in the spring.

Growing grasses and legumes for pasture and hay is effective in controlling water erosion. This soil is moderately well suited to birdsfoot trefoil, reed canarygrass, and switchgrass. It is moderately suited to tall fescue, big bluestem, and indiangrass. Water-tolerant species grow best. Water erosion during seedbed preparation is the main problem. Timely tillage and a quickly established ground cover help to prevent excessive soil loss.

This soil is suited to building site development and certain onsite waste disposal systems. The high shrink-swell potential and the wetness are limitations on sites for dwellings and small commercial buildings. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling of the soil. Installing drainage tile around footings helps to prevent the damage caused by excessive wetness. Adequate reinforcement steel, expansion joints, and a sand or gravel base for sidewalks and driveways can help to prevent the damage caused by shrinking and swelling and by frost action. The soil generally is unsuitable as a site for septic tank absorption fields because of the wetness and the very slow permeability. Properly designed sewage lagoons can function adequately. Leveling of the lagoon site may be necessary.

Low strength, the high shrink-swell potential, the wetness, and the potential for frost action limit this soil as a site for local roads and streets. Strengthening the base material with crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads so that they shed water and providing adequate roadside ditches and culverts minimize the damage caused by shrinking and swelling, wetness, and frost action.

The land capability classification is IIe. No woodland ordination symbol is assigned.

04—Haig silt loam. This nearly level, poorly drained soil is on high stream terraces adjacent to flood plains. Individual areas are irregular in shape and range from about 20 to more than 100 acres in size.

Typically, the surface layer is black, friable silt loam about 9 inches thick. The subsurface layer is black, friable silty clay loam about 4 inches thick. The subsoil extends to a depth of 60 inches or more. It is firm. The upper part is black silty clay; the next part is very dark gray and dark gray, mottled silty clay; and the lower part is grayish brown and olive gray, mottled silty clay and silty clay loam. In some areas the upper part of the subsoil is not so gray.

Permeability and surface runoff are very slow. Available water capacity is high. Natural fertility also is high, and organic matter content is moderate. The surface layer is friable but can be easily tilled only within a fairly narrow range in moisture content. The shrink-swell potential of the subsoil is high. A perched water table is at a depth of 1 to 2 feet during most winter and spring months.

Most areas are used for cultivated crops. A few are used for hay and pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain. The wetness is the major limitation. If the area is large enough, land smoothing and leveling and surface drains can remove excess water.

This soil is moderately well suited to birdsfoot trefoil, reed canarygrass, and switchgrass. It is moderately suited to tall fescue, big bluestem, and indiangrass. Water-tolerant species grow best. The excessively wet periods should be considered when a grazing system is designed.

This soil is suited to building site development and certain onsite waste disposal systems. The high shrink-swell potential and the wetness are limitations on sites for dwellings and small commercial buildings. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling of the soil. Installing drainage tile around footings helps to prevent the damage caused by excessive wetness. Adequate reinforcement steel, expansion joints, and a sand or gravel base for sidewalks and driveways can help to prevent the damage caused by shrinking and swelling and by frost action. The soil generally is unsuitable as a site for septic tank absorption fields because of the wetness and the very slow permeability. Properly designed sewage lagoons can function adequately.

Low strength, the high shrink-swell potential, the wetness, and the potential for frost action limit this soil as a site for local roads and streets. Strengthening the base material with crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads so that they shed water and providing adequate roadside ditches and culverts minimize the damage caused by shrinking and swelling, wetness, and frost action.

The land capability classification is IIw. No woodland ordination symbol is assigned.

06—Edina silt loam. This nearly level, poorly drained soil is on wide ridgetops in the uplands. Individual areas are irregular in shape and range from about 5 to more than 200 acres in size.

Typically, the surface layer is very dark gray, very friable silt loam about 10 inches thick. The subsurface layer is dark grayish brown, very friable silt loam about 7 inches thick. The subsoil is mottled, firm silty clay about 33 inches thick. The upper part is very dark gray, and the lower part is dark grayish brown and grayish brown. The substratum to a depth of 60 inches or more is grayish brown, mottled, firm silty clay loam. In some areas, the soil does not have the lighter colored subsurface layer and the content of clay in the subsoil is not so high.

Permeability and surface runoff are very slow. Available water capacity is high. Natural fertility also is high, and organic matter content is moderate. The surface layer is very friable but can be easily tilled only within a fairly narrow range in moisture content. The shrink-swell potential of the subsoil is very high. A perched water table is at a depth of 0.5 foot to 2.0 feet during most winter and spring months.

Most areas are used for cultivated crops. A few areas are used for hay and pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain. Wetness is the major limitation. If the area is large enough, land smoothing and leveling and surface drains can remove excess water.

This soil is moderately well suited to birdsfoot trefoil, reed canarygrass, and switchgrass. It is moderately suited to tall fescue, big bluestem, and indiangrass. The excessively wet periods should be considered when a grazing system is designed.

This soil is suited to building site development and certain onsite waste disposal systems. The very high shrink-swell potential and the wetness are limitations on sites for dwellings and small commercial buildings. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling of the soil. Installing drainage tile around footings helps to prevent the damage caused by excessive wetness. Adequate reinforcement steel, expansion joints, and a sand or gravel base for sidewalks and driveways can help to prevent the damage caused by shrinking and swelling and by frost action. The soil generally is unsuitable as a site for septic tank absorption fields because of the wetness and the very slow permeability. Properly designed sewage lagoons can function adequately.

Low strength, the very high shrink-swell potential, the wetness, and the potential for frost action limit this soil as a site for local roads and streets. Strengthening the base material with crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads so that they shed water and providing adequate roadside ditches and culverts minimize the damage caused by shrinking and swelling, wetness, and frost action.

The land capability classification is IIw. No woodland ordination symbol is assigned.

11B—Grundy silt loam, 2 to 5 percent slopes. This gently sloping, somewhat poorly drained soil is on narrow to broad ridgetops and the upper side slopes in the uplands and on high stream terraces. Individual areas are irregular in shape and range from about 10 to more than 500 acres in size.

Typically, the surface layer is black, friable silt loam about 6 inches thick. The subsurface layer is mixed black and very dark gray, friable silt loam about 5 inches thick. The subsoil is about 38 inches thick. It is mottled and firm. In sequence downward, it is dark grayish brown silty clay loam, dark grayish brown silty clay, and grayish brown silty clay loam. The substratum to a depth of 60 inches or more is grayish brown, mottled, firm silty clay loam. In some eroded areas the dark surface soil is silty clay loam less than 10 inches thick. In places the subsoil has more sand and pebbles.

Permeability is slow. Surface runoff is medium. Available water capacity and natural fertility are high. Organic matter content is moderate. The surface layer is friable and can be easily tilled within a moderate range in moisture content. The shrink-swell potential of the subsoil is high. A perched water table is at a depth of 1 to 3 feet during most winter and spring months.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain. Water erosion is a hazard if the soil is used for cultivated crops. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is effective in controlling water erosion. This soil is well suited to ladino clover. It is moderately well suited to birdsfoot trefoil, tall fescue, big bluestem, and switchgrass. It is moderately suited to alfalfa, red clover, orchardgrass, and smooth brome. Water-tolerant species grow best. Water erosion during seedbed preparation is the main problem. Timely tillage and a quickly established ground cover help to prevent excessive soil loss.

This soil is suited to building site development and certain onsite waste disposal systems. The high shrink-swell potential and the wetness are limitations on sites for dwellings and small commercial buildings. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling of the soil. Installing drainage tile around footings helps to prevent the damage caused by excessive wetness. Adequate reinforcement steel, expansion joints, and a sand or gravel base for sidewalks and driveways can help to prevent the damage caused by shrinking and swelling and by frost action. The soil generally is unsuitable as a site for septic tank absorption fields because of the wetness and the very slow permeability. Properly designed sewage lagoons can function adequately. Leveling of the lagoon site may be necessary.

Low strength, the high shrink-swell potential, the wetness, and the potential for frost action limit this soil as a site for local roads and streets. Strengthening the base material with crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads so that they shed water and providing adequate roadside ditches and culverts minimize the damage caused by shrinking and swelling, wetness, and frost action.

The land capability classification is IIe. No woodland ordination symbol is assigned.

12B2—Grundy silty clay loam, 2 to 5 percent slopes, eroded. This gently sloping, somewhat poorly drained soil is on narrow ridgetops and the upper side slopes in the uplands and on high stream terraces. Water erosion has removed some of the original surface layer. The remaining surface soil has been mixed with the upper part of the subsoil by tillage. Individual areas are irregular in shape and range from about 5 to more than 100 acres in size.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsoil is about 42 inches thick. It is mottled and firm. The upper part is dark grayish brown silty clay, and the lower part is grayish brown silty clay and silty clay loam. The substratum to a depth of 60 inches or more is grayish brown, mottled, firm silty clay loam. In places the dark surface soil is silt loam more than 10 inches thick. In some small areas the lower part of the subsoil has more sand and pebbles. In a few places the soil is so eroded that most of the present surface layer is subsoil material.

Permeability is slow. Surface runoff is medium. Available water capacity and natural fertility are high. Organic matter content is moderate. The surface layer is sticky when wet and can be easily tilled only within a somewhat narrow range in moisture content. The shrink-swell potential of the subsoil is high. A perched water table is at a depth of 1 to 3 feet during most winter and spring months.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain. Further water erosion is a serious hazard if the soil is used for cultivated crops. A combination of conservation practices helps to prevent excessive soil loss. A system of conservation tillage, such as no-till farming, leaves a protective amount of crop residue on the surface after planting. Many areas are smooth enough and large enough to be terraced and farmed on the contour. If exposed by terracing, the clayey subsoil cannot be easily tilled, is low in fertility, and has a low available water capacity. As a result, special management may be needed. The exposed subsoil can be covered with topsoil removed from adjacent areas under construction. Contour stripcropping provides permanent strips of grasses or legumes. These strips are alternated with row crops, which are planted on the contour. These grasses and

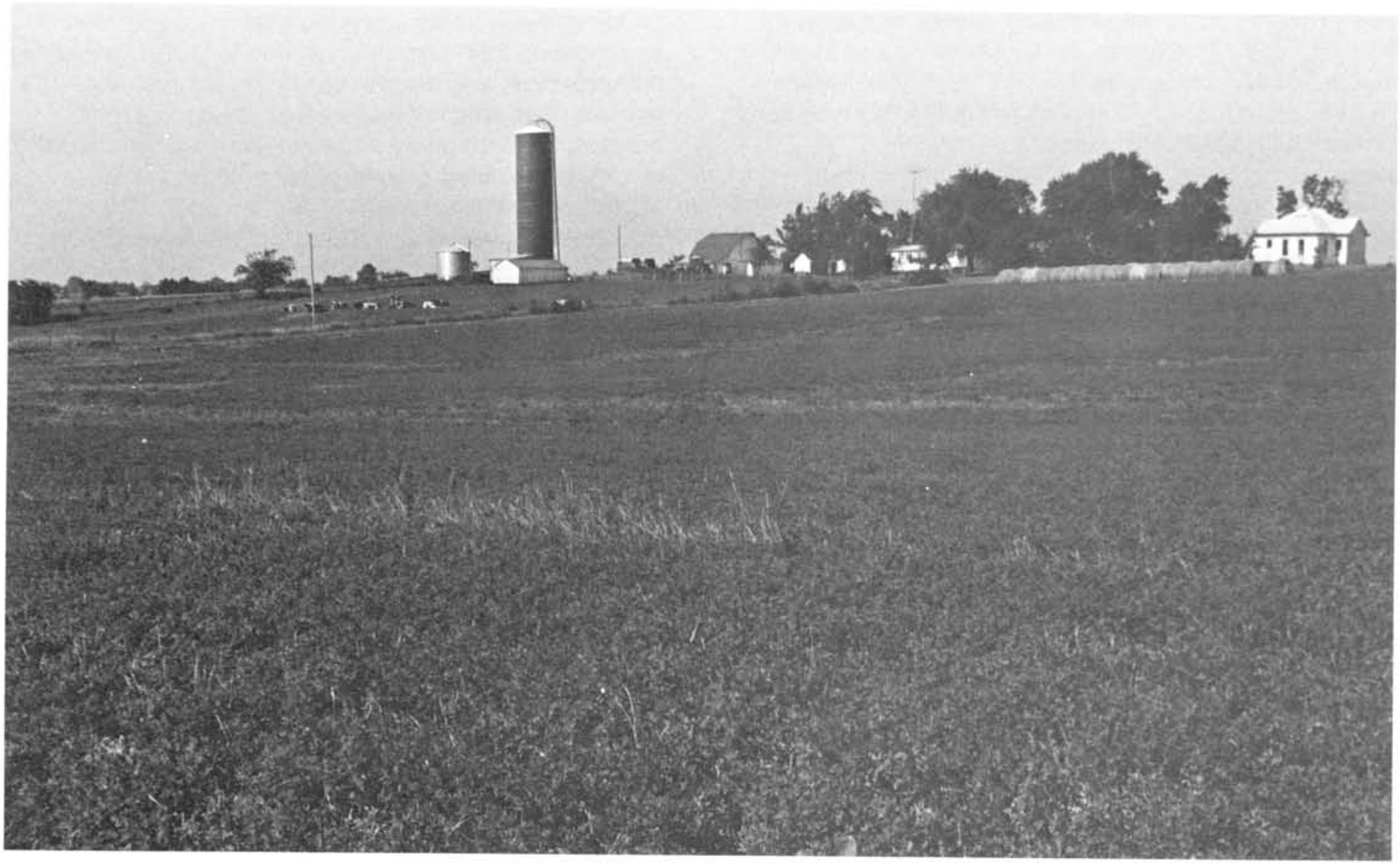


Figure 6.—Hayfield in an area of Grundy silty clay loam, 2 to 5 percent slopes, eroded.

legumes minimize water erosion. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is effective in controlling water erosion (fig. 6). This soil is well suited to ladino clover. It is moderately well suited to birdsfoot trefoil, tall fescue, big bluestem, and switchgrass. It is moderately suited to alfalfa, red clover, orchardgrass, and smooth brome. Water-tolerant species grow best. Water erosion during seedbed preparation is the main problem. Timely tillage and a quickly established ground cover help to prevent excessive soil loss.

This soil is suited to building site development and certain onsite waste disposal systems. The high shrink-swell potential and the wetness are limitations on sites for dwellings and small commercial buildings. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling of the soil. Installing drainage tile around footings helps to prevent the damage caused by excessive wetness. Adequate reinforcement steel, expansion joints, and a sand or gravel base for sidewalks and driveways can help to prevent the damage caused by shrinking and swelling and by frost action. The soil generally is unsuitable as a site for septic tank absorption fields because of the wetness and the slow permeability. Properly designed sewage lagoons can function adequately. Leveling of the lagoon site may be necessary.

Low strength, the high shrink-swell potential, the wetness, and the potential for frost action limit this soil as a site for local roads and streets. Strengthening the base material with crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads so that they shed water and providing adequate roadside ditches and culverts minimize the damage caused by shrinking and swelling, wetness, and frost action.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

14C—Lamoni loam, 5 to 9 percent slopes. This moderately sloping, somewhat poorly drained soil is on ridgetops and the upper side slopes in the uplands. Individual areas are irregular in shape and range from about 10 to more than 100 acres in size.

Typically, the surface layer is very dark gray, friable loam about 8 inches thick. The subsurface layer is very dark grayish brown, friable clay loam about 3 inches thick. The subsoil to a depth of 60 inches or more is mottled clay. In sequence downward, it is dark grayish brown and firm, grayish brown and very firm, and gray and firm. In some eroded areas the dark surface soil is clay loam less than 10 inches thick. In places the surface soil and subsoil have a lower content of sand and pebbles.

Included with this soil in mapping are a few small areas of the moderately well drained Shelby soils. These soils generally are on the lower side slopes. They make up about 5 percent of the unit.

Permeability is slow in the Lamoni soil. Surface runoff is medium. Available water capacity is moderate. Natural fertility is medium, and organic matter content is moderate. The surface layer is friable and can be easily tilled within a moderate range in moisture content. The shrink-swell potential of the subsoil is high. A perched water table is at a depth of 1 to 3 feet during most winter and spring months.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain. Water erosion is a hazard if the soil is used for cultivated crops. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is effective in controlling water erosion. This soil is well suited to ladino clover. It is moderately well suited to birdsfoot trefoil, tall fescue, big bluestem, and switchgrass. It is moderately suited to alfalfa, red clover, orchardgrass, and smooth brome. Water-tolerant species grow best. Water erosion during seedbed preparation is the main problem. Timely tillage and a quickly established ground cover help to prevent excessive soil loss.

This soil is suited to building site development and certain onsite waste disposal systems. The high shrink-swell potential and the wetness are limitations on sites for dwellings and small commercial buildings. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling of the soil. Installing drainage tile around footings helps to prevent the damage caused by excessive wetness. Adequate reinforcement steel, expansion joints, and a sand or gravel base for sidewalks and driveways can help to prevent the damage caused by shrinking and swelling and by frost action. The soil generally is unsuitable as a site for septic tank absorption fields because of the wetness and the slow permeability. Properly designed sewage lagoons can function adequately. Leveling of the lagoon site may be necessary.

Low strength, the high shrink-swell potential, the wetness, and the potential for frost action limit this soil as a site for local roads and streets. Strengthening the base material with crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads so that they shed water and providing adequate roadside ditches and culverts minimize the damage caused by shrinking and swelling, wetness, and frost action.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

15C2—Lamoni clay loam, 5 to 9 percent slopes, eroded. This moderately sloping, somewhat poorly drained soil is on side slopes and narrow ridgetops in the uplands. Water erosion has removed some of the original surface layer. The remaining surface soil has been mixed with the upper part of the subsoil by tillage. Individual areas are irregular in shape and range from about 10 to more than 200 acres in size.

Typically, the surface layer is black, friable clay loam about 6 inches thick. The subsoil is about 48 inches thick. It is mottled and firm. In sequence downward, it is dark brown clay loam, dark grayish brown clay, grayish brown clay, and yellowish brown clay loam. The substratum to a depth of 60 inches is yellowish brown, mottled, firm clay loam. In some areas the soil is so eroded that most of the present surface layer is subsoil material. In some places the dark surface soil is loam more than 10 inches thick. In other places the subsoil has a lower content of sand and pebbles.

Included with this soil in mapping are a few small areas of the moderately well drained Shelby soils. These soils generally are on the lower, steeper side slopes. They make up about 5 percent of the unit.

Permeability is slow in the Lamoni soil. Surface runoff is medium. Available water capacity is moderate. Natural fertility is medium, and organic matter content is moderate. The surface layer is sticky when wet and can be easily tilled only within a somewhat narrow range in moisture content. The shrink-swell potential of the subsoil is high. A perched water table is at a depth of 1 to 3 feet during most winter and spring months.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain. Further water erosion is a serious hazard if the soil is used for cultivated crops. A combination of conservation practices helps to prevent excessive soil loss. No-till farming and other kinds of conservation tillage leave a protective amount of crop residue on the surface after planting. Many areas are smooth enough and large enough to be terraced and farmed on the contour. If exposed by terracing, the clayey subsoil cannot be easily tilled, is low in fertility, and has a low available water capacity. As a result, special management may be needed. The exposed subsoil can be covered with topsoil removed from adjacent areas under construction. Contour stripcropping provides permanent strips of grasses or legumes. These strips are alternated with row crops which are planted on the contour. The grasses and legumes minimize water erosion. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is effective in controlling water erosion. This soil is well suited to ladino clover. It is moderately well suited to birdsfoot trefoil, tall fescue, big bluestem, and switchgrass. It is moderately suited to alfalfa, red clover, orchardgrass, and smooth brome. Water-tolerant species grow best. Water erosion during seedbed preparation is the main management problem. Timely tillage and a quickly established ground cover help to prevent excessive soil loss.

This soil is suited to building site development and certain onsite waste disposal systems. The high shrink-swell potential and the wetness are limitations on sites for dwellings and small commercial buildings. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling of the soil. Installing drainage tile around footings helps to prevent the damage caused by excessive wetness. Adequate reinforcement steel, expansion joints, and a sand or gravel base for sidewalks and driveways can help to prevent the damage caused by shrinking and swelling and by frost action. The soil generally is unsuitable as a site for septic tank absorption fields because of the wetness and the slow permeability. Properly designed sewage lagoons can function adequately. Leveling of the lagoon site may be necessary.

Low strength, the high shrink-swell potential, the wetness, and the potential for frost action limit this soil as a site for local roads and streets. Strengthening the base material with crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads so that they shed water and providing adequate roadside ditches and culverts minimize the damage caused by shrinking and swelling, wetness, and frost action.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

16D—Shelby loam, 9 to 14 percent slopes. This strongly sloping, moderately well drained soil is on the sides of narrow ridges in the uplands. Individual areas are irregular in shape and range from about 5 to more than 200 acres in size.

Typically, the surface layer is black, friable loam about 7 inches thick. The subsurface layer is very dark brown, friable clay loam about 5 inches thick. The subsoil is firm clay loam about 25 inches thick. The upper part is dark brown and brown, and the lower part is yellowish brown and mottled. The substratum to a depth of 60 inches or more is yellowish brown, mottled, firm clay loam. In some eroded areas the dark surface soil is clay loam less than 10 inches thick.

Included with this soil in mapping are a few small areas of the somewhat poorly drained Lamoni soils. These soils generally are on the upper side slopes. They make up about 5 percent of the unit.

Permeability is moderately slow in the Shelby soil. Surface runoff is medium. Available water capacity and natural fertility are high. Organic matter content is moderate. The surface layer is friable and can be easily tilled within a moderate range in moisture content. The shrink-swell potential is moderate.

Most areas are used for hay or pasture. Some areas are used for cultivated crops or small grain. Growing grasses and legumes for pasture and hay is effective in controlling water erosion. This soil is well suited to birdsfoot trefoil, red clover, reed canarygrass, and tall fescue. It is moderately well suited to alfalfa, orchardgrass, and smooth brome. It is well suited to switchgrass and moderately well suited to most other warm-season grasses. Water erosion during seedbed preparation is the main problem. Timely seedbed preparation helps to ensure a good ground cover. The seedbed should be prepared on the contour. Overgrazing should be avoided. Measures that maintain fertility and control brush are necessary in existing stands of grass.

This soil is suited to cultivated crops and small grain. Water erosion is a hazard if the soil is used for cultivated crops. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to building site development and onsite waste disposal if proper design and installation procedures are used. Basement walls, foundations, and footings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the soil. Dwellings should be designed so that they conform to the natural slope of the land. Otherwise, grading is needed to modify the slope. If the more sloping areas are exposed when a building site is leveled, special management is needed to establish a vegetative cover and divert runoff away from the foundation.

Because of the moderately slow permeability in the subsoil and the slope, septic tank absorption fields generally do not function adequately unless they are enlarged and are designed to operate across the slope. Properly constructed sewage lagoons can function adequately. The slope is a severe limitation, but it can be modified by grading. Otherwise, sewage can be piped to adjacent areas where the soils are better suited to lagoons.

Low strength, the slope, the potential for frost action, and the shrink-swell potential limit this soil as a site for local roads and streets. Strengthening the base material with crushed rock or other suitable material can help to prevent the road damage caused by low strength. Some cutting and filling may be necessary because of the slope. Otherwise, the roads can be designed so that they conform to the natural slope of the land. A drainage system that includes ditches and culverts can help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

16E—Shelby loam, 14 to 20 percent slopes. This moderately steep, moderately well drained soil is on the lower side slopes of narrow ridges in the uplands. Individual areas are irregular in shape and range from about 5 to more than 200 acres in size.

Typically, the surface layer is black, friable loam about 11 inches thick. The subsoil is clay loam about 25 inches thick. The upper part is dark brown and friable, the next part is brown and firm, and the lower part is dark yellowish brown, mottled, and firm. The substratum to a depth of 60 inches or more is yellowish brown, mottled, firm clay loam. In some eroded areas the dark surface soil is clay loam less than 10 inches thick.

Permeability is moderately slow. Surface runoff is rapid. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The shrink-swell potential also is moderate.

Most areas are used for hay or pasture. A few small areas are used for cultivated crops or small grain. Growing grasses and legumes for pasture and hay is effective in controlling water erosion. This soil is well suited to birdsfoot trefoil, red clover, reed canarygrass, and tall fescue. It is moderately well suited to alfalfa, orchardgrass, and smooth brome. It is well suited to switchgrass and moderately well suited to most other warm-season grasses. Water erosion during seedbed preparation is the main problem. Timely seedbed preparation helps to ensure a good ground cover. Preparing the seedbed on the contour and growing nurse crops or leaving crop residue on the surface help to prevent excessive soil loss. Overgrazing should be avoided. Measures that maintain fertility and control brush are necessary in existing stands of grass.

This soil is suited to cultivated crops and small grain only if the crops are grown on a limited basis and intensive measures to control water erosion are applied. Erosion is a serious hazard if the soil is used for cultivated crops. A combination of conservation practices helps to prevent excessive soil loss. No-till farming and other kinds of conservation tillage leave a protective cover of crop residue on the surface after planting. Contour stripcropping provides permanent strips of grasses or legumes. These strips are alternated with cultivated crops or small grain, which are planted on the contour. The grasses and legumes minimize water erosion. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to building site development and onsite waste disposal if proper design and installation procedures are used. Basement walls, foundations, and footings for small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the soil. Dwellings should be designed so that they conform to the natural slope of the land. Otherwise, grading is needed to modify the slope. If the more sloping areas are exposed when a building site is leveled, special managagement is needed to establish a vegetative cover and divert runoff away from the foundation.

Because of the moderately slow permeability in the subsoil and the slope, septic tank absorption fields generally do not function adequately unless they are enlarged and are designed to operate across the slope. Properly constructed sewage lagoons can function adequately. The slope is a severe limitation, but it can be modified by grading. Otherwise, sewage can be piped to adjacent areas where the soils are better suited to lagoons.

Low strength, the slope, frost action, and the shrink-swell potential limit this soil as a site for local roads and streets. Crushed rock or other suitable base material can help to prevent the road damage caused by low strength. Some cutting and filling may be necessary because of the slope. Otherwise, the roads should be designed so that they conform to the natural slope of the land. A drainage system that includes roadside ditches and culverts can help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IVe. No woodland ordination symbol is assigned.

17D2—Shelby clay loam, 9 to 14 percent slopes, eroded. This strongly sloping, moderately well drained soil is on side slopes adjacent to narrow, convex ridgetops in the uplands. Water erosion has removed some of the original surface layer. The remaining surface soil has been mixed with the upper part of the subsoil by tillage. Individual areas are irregular in shape and range from about 10 to more than 200 acres in size.

Typically, the surface layer is very dark grayish brown, friable clay loam about 8 inches thick. The subsoil is firm clay loam about 25 inches thick. The upper part is brown, the next part is dark yellowish brown and mottled, and the lower part is yellowish brown and mottled. The substratum to a depth of 60 inches or more is yellowish brown, mottled, calcareous, firm clay loam. In some areas the soil is so eroded that most of the present surface layer is subsoil material. In some places the dark surface soil is loam. In other places the depth to calcareous clay loam is less than 30 inches.

Included with this soil in mapping are a few small areas of the somewhat poorly drained Lamoni soils. These soils generally are higher on the side slopes than the Shelby soils. They make up about 5 percent of the unit.

Permeability is moderately slow in the Shelby soil. Surface runoff is medium. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The surface layer is sticky when wet and can be easily tilled only within a somewhat narrow range in moisture content. The shrink-swell potential is moderate.

Most areas are used for cultivated crops, hay, or pasture. Further erosion is a serious hazard if the soil is used for cultivated crops. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Some areas have small gullies, which should be reshaped. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is effective in controlling water erosion. This soil is well suited to birdsfoot trefoil, red clover, reed canarygrass, and tall fescue. It is moderately well suited to alfalfa, orchardgrass, and smooth brome. It is well suited to switchgrass and moderately well suited to most other warm-season grasses. Water erosion during seedbed preparation is the main problem. Timely seedbed preparation helps to ensure a good ground cover. The seedbed should be prepared on the contour. Overgrazing should be avoided. Measures that maintain fertility and control brush are necessary in existing stands of grass. A few areas have gullies, which should be reshaped and reseeded to grasses.

This soil is suited to building site development and onsite waste disposal if proper design and installation procedures are used. Basement walls, foundations, and footings for small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the soil. Dwellings should be designed so that they conform to the natural slope of the land. Otherwise, grading is needed to modify the slope. If the more sloping areas are exposed when a building site is leveled, special management is needed to establish a vegetative cover and divert runoff away from the foundation.

Because of the moderately slow permeability and the slope, septic tank absorption fields generally do not function adequately unless they are enlarged and are designed to operate across the slope. Properly constructed sewage lagoons can function adequately. The slope is a severe limitation, but it can be modified by grading. Otherwise, sewage can be piped to adjacent areas where the soils are better suited to lagoons.

Low strength, the slope, frost action, and the shrink-swell potential limit this soil as a site for local roads and streets. Crushed rock or other suitable base material can help to prevent the road damage caused by low strength. Some cutting and filling may be necessary because of the slope. Otherwise, the roads should be designed so that they conform to the natural slope of the land. A drainage system that includes roadside ditches and culverts can help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IVe. No woodland ordination symbol is assigned.

17E2—Shelby clay loam, 14 to 20 percent slopes, eroded. This moderately steep, moderately well drained soil is on the lower side slopes adjacent to narrow, convex ridgetops in the uplands. Water erosion has removed some of the original surface layer. The remaining surface soil has been mixed with the upper part of the subsoil by tillage. Individual areas are irregular in shape and range from about 5 to 80 acres in size.

Typically, the surface layer is black, friable clay loam about 6 inches thick. The subsoil is firm clay loam about 25 inches thick. The upper part is brown and dark yellowish brown, and the lower part is dark yellowish brown and mottled. The substratum to a depth of 60 inches or more is yellowish brown, mottled, calcareous, firm clay loam. In some areas the soil is so eroded that most of the present surface layer is subsoil material. In some places the dark surface soil is loam. In other places the depth to calcareous clay loam is less than 30 inches.

Permeability is moderately slow. Surface runoff is rapid. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The shrink-swell potential also is moderate.

Most areas are used for hay or pasture. Because of the slope and a severe hazard of further water erosion, this soil is unsuited to cultivated crops. It is well suited to birdsfoot trefoil, red clover, reed canarygrass, and tall fescue. It is moderately well suited to alfalfa, orchardgrass, and smooth brome. It is well suited to switchgrass and moderately well suited to most other warm-season grasses. Water erosion during seedbed preparation is the main problem. Timely seedbed preparation helps to ensure a good ground cover. Preparing the seedbed on the contour and growing nurse crops or leaving crop residue on the surface help to prevent excessive soil loss. Overgrazing should be avoided. Measures that maintain fertility and control brush are necessary in existing stands of grass. A few areas have gullies, which should be reshaped and reseeded to grasses.

This soil is suited to building site development and onsite waste disposal if proper design and installation procedures are used. Basement walls, foundations, and footings for small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the soil. Dwellings should be designed so that they conform to the natural slope of the land. Otherwise, grading is needed to modify the slope. If the more sloping areas are exposed when a building site is leveled, special management is needed to establish a vegetative cover and divert runoff away from the foundation.

Because of the moderately slow permeability and the slope, septic tank absorption fields generally do not function adequately unless they are enlarged and are designed to operate across the slope. Properly constructed sewage lagoons can function adequately. The slope is a severe limitation, but it can be modified by grading. Otherwise, sewage can be piped to adjacent areas where soils are better suited to lagoons.

Low strength, the slope, frost action, and the shrink-swell potential limit this soil as a site for local roads and streets. Crushed rock or other suitable base material can help to prevent the road damage caused by low strength. Some cutting and filling may be necessary because of the slope. Otherwise, the roads should be designed so that they conform to the natural slope of the land. A drainage system that includes roadside ditches and culverts can help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is VIe. No woodland ordination symbol is assigned.

21D—Gara loam, 9 to 14 percent slopes. This strongly sloping, moderately well drained soil is on side slopes adjacent to the larger streams and their tributaries. Individual areas are irregular in shape and range from about 5 to more than 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable loam about 7 inches thick. The subsurface layer is brown, friable loam about 3 inches thick. The subsoil is firm clay loam about 26 inches thick. The upper part is dark brown, the next part is dark yellowish brown, and the lower part is dark yellowish brown and mottled. The substratum to a depth of 60 inches or more is yellowish brown, mottled, firm clay loam. In some areas the soil is moderately steep. In places the depth to calcareous clay loam is less than 36 inches. In a few eroded areas, the surface layer is clay loam.

Included with this soil in mapping are a few small areas of the somewhat poorly drained Armstrong soils. These soils generally are higher on the side slopes than the Gara soils. They make up about 5 percent of the unit.

Permeability is moderately slow in the Gara soil. Surface runoff is medium. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The surface layer is friable and can be easily tilled within a moderate range in moisture content. The shrink-swell potential is moderate.

Many areas are used as woodland. A few small areas support native hardwoods. Some areas are used for hay or pasture and a few areas are used for cultivated crops and small grain.

This soil is suited to trees. The hazards and limitations that affect planting and harvesting are slight.

Growing grasses and legumes for pasture and hay is effective in controlling water erosion. This soil is well suited to birdsfoot trefoil, red clover, reed canarygrass, and tall fescue. It is moderately well suited to alfalfa, orchardgrass, and smooth brome. It is well suited to switchgrass and moderately well suited to most other warm-season grasses. Water erosion during seedbed preparation is the main problem. Timely seedbed preparation helps to ensure a good ground cover. The seedbed should be prepared on the contour. Overgrazing should be avoided. Measures that maintain fertility and control brush are necessary in existing stands of grass.

Cultivated crops and small grain are suitable on this soil only if they are grown on a limited basis and if intensive erosion-control measures are applied. Water erosion is a serious hazard if the soil is used for cultivated crops. A combination of conservation practices helps to prevent excessive soil loss. A system of conservation tillage, such as no-till farming, leaves a protective cover of crop residue on the surface after planting. Contour stripcropping provides permanent strips of grasses or legumes. These strips are alternated with cultivated crops or small grain, which is planted on the contour. The grasses and legumes minimize water erosion. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to building site development and onsite waste disposal if proper design and installation procedures are used. Basement walls, foundations, and footings for small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the soil. Dwellings should be designed so that they conform to the natural slope of the land. Otherwise, grading is needed to modify the slope. If the more sloping areas are exposed when a building site is leveled, special management is needed to establish a vegetative cover and divert runoff away from the foundation.

Because of the moderately slow permeability in the subsoil and the slope, septic tank absorption fields generally do not function adequately unless they are enlarged and are designed to operate across the slope. Properly constructed sewage lagoons can function adequately. The slope is a severe limitation, but it can be modified by grading. Otherwise, sewage can be piped to adjacent areas where the soils are better suited to lagoons.

Low strength, the slope, frost action, and the shrink-swell potential limit this soil as a site for local roads and streets. Crushed rock or other suitable base material can help to prevent the road damage caused by low strength. Some cutting and filling may be necessary because of the slope. Otherwise, the roads should be designed so that they conform to the natural slope of the land. A drainage system that includes roadside ditches and culverts can help to prevent the damage caused by frost action and by shrinking and swelling of the soil.

The land capability classification is IVe. The woodland ordination symbol is 3A.

21E—Gara loam, 14 to 20 percent slopes. This moderately steep, moderately well drained soil is on upland side slopes adjacent to stream channels and flood plains. Individual areas are irregular in shape and range from about 5 to more than 100 acres in size.

Typically, the surface layer is very dark gray, friable loam about 7 inches thick. The subsurface layer is dark grayish brown and brown, friable loam about 4 inches thick. The subsoil is dark yellowish brown, firm clay loam about 29 inches thick. It is mottled in the lower part. The substratum to a depth of 60 inches or more is yellowish brown, mottled, firm clay loam. In some areas the soil is strongly sloping or is steep and very steep. In places the depth to calcareous clay loam is less than 36 inches. In a few eroded areas, the surface layer is clay loam.

Included with this soil in mapping are a few small areas of the moderately steep to very steep, moderately deep Vanmeter soils. These soils are on convex side slopes and in areas with short, steep slopes that parallel stream channels and flood plains. They make up about 5 percent of the unit.

Permeability is moderately slow in the Gara soil. Surface runoff is rapid. Available water capacity is high. Natural fertility is low, and organic matter content is moderate. The shrink-swell potential also is moderate.

Many areas are used as woodland. Some areas are used for hay or pasture. This soil is too steep for use as cropland and should be tilled only when pasture seeding is needed.

A few areas support native hardwoods. This soil is suited to trees. The hazard of water erosion and the equipment limitation are management concerns. Constructing logging roads and skid trails on the contour minimizes the steepness and length of slopes, and the concentration of water. In the steepest areas the logs should be yarded uphill to logging roads and skid trails. Seeding of disturbed areas may be necessary after harvesting is completed. Protection from fire and grazing helps to ensure an adequate ground cover for erosion control and for regeneration of the stand.

Growing grasses and legumes for pasture and hay is effective in controlling water erosion. This soil is well suited to birdsfoot trefoil, red clover, reed canarygrass, and tall fescue. It is moderately well suited to alfalfa, orchardgrass, and smooth brome. It is well suited to switchgrass and moderately well suited to most other warm-season grasses. Water erosion during seedbed preparation is the main problem. Timely seedbed preparation helps to ensure a good ground cover. The seedbed should be prepared on the contour. Overgrazing should be avoided. Measures that maintain fertility and control brush are necessary in existing stands of grass.

This soil is suited to building site development and onsite waste disposal if proper design and installation procedures are used. Basement walls, foundations, and footings for small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the soil. Dwellings should be designed so that they conform to the natural slope of the land. Otherwise, grading is needed to modify the slope. If the more sloping areas are exposed when a building site is leveled, special management is needed to establish a vegetative cover and divert runoff away from the foundation.

Because of the moderately slow permeability in the subsoil and the slope, septic tank absorption fields generally do not function adequately unless they are enlarged and are designed to operate across the slope. Properly constructed sewage lagoons can function adequately. The slope is a severe limitation, but it can be modified by grading. Otherwise, sewage can be piped to adjacent areas where the soils are better suited to lagoons.

Low strength, the slope, frost action, and the shrink-swell potential limit this soil as a site for local roads and streets. Crushed rock or other suitable base material can help to prevent the road damage caused by low strength. Some cutting and filling may be necessary because of the slope. Otherwise, the roads should be designed so that they conform to the natural slope of the land. A drainage system that includes roadside ditches and culverts can help to prevent the damage caused by frost action and by shrinking and swelling of the soil.

The land capability classification is VIe. The woodland ordination symbol is 3R.

22D2—Gara clay loam, 9 to 14 percent slopes, eroded. This strongly sloping, moderately well drained soil is on upland side slopes adjacent to stream channels and flood plains. Water erosion has removed some of the original surface layer. The remaining surface soil has been mixed with the upper part of the subsoil by tillage. Individual areas are irregular in shape and range from about 5 to more than 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable clay loam about 6 inches thick. The subsoil is firm clay loam about 30 inches thick. The upper part is dark yellowish brown, and the lower part is dark yellowish brown and yellowish brown and is mottled. The substratum to a depth of 60 inches or more is yellowish brown, mottled, calcareous, firm clay loam. In some areas the soil is moderately steep. In places the depth to calcareous clay loam is less than 36 inches. In a few uneroded areas, the dark surface layer is loam.

Included with this soil in mapping are a few small areas of the somewhat poorly drained Armstrong soils. These soils are higher on the side slopes than the Gara soil. They make up about 5 percent of the unit.

Permeability is moderately slow in the Gara soil. Surface runoff is medium. Available water capacity is high. Natural fertility is medium, and organic matter content is low. The surface layer is sticky when wet and can be easily tilled only within a somewhat narrow range in moisture content. The shrink-swell potential is moderate.

Many areas are used for hay or pasture. Some areas are used as woodland, and a few are used for cultivated crops or small grain. Growing grasses and legumes for pasture and hay is effective in controlling water erosion. This soil is well suited to birdsfoot trefoil, red clover, reed canarygrass, and tall fescue. It is moderately well suited to alfalfa, orchardgrass, and smooth brome. It is well suited to switchgrass and moderately well suited to most other warm-season grasses. Water erosion during seedbed preparation is the main problem. Timely seedbed preparation helps to ensure a good ground cover. Preparing the seedbed helps to prevent excess soil loss on the contour. Overgrazing should be avoided. Measures that maintain or improve the organic matter content and fertility and control brush are necessary in existing stands of grass. A few areas have gullies, which should be reshaped and reseeded to grasses.

A few small areas support native hardwoods. This soil is suited to trees. The hazards and limitations that affect planting and harvesting are slight.

This soil is suitable for row crops and small grain only if the crops are grown on a limited basis and intensive erosion-control measures are applied. Further water erosion is a serious hazard if the soil is used for cultivated crops. A combination of conservation practices helps to prevent excessive soil loss. No-till farming and other kinds of conservation tillage leave a protective cover of crop residue on the surface after planting. Contour stripcropping provides permanent strips of grasses or legumes. These strips are alternated with small grain or cultivated crops, which are planted on the contour. The grasses and legumes minimize water erosion. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to building site development and onsite waste disposal if proper design and installation procedures are used. Basement walls, foundations, and footings for small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the soil. Dwellings should be designed so that they conform to the natural slope of the land. Otherwise, grading is needed to modify the slope. If the more sloping areas are exposed when a building site is leveled, special management is needed to establish a vegetative cover and divert runoff away from the foundation.

Because of the moderately slow permeability and the slope, septic tank absorption fields generally do not function adequately unless they are enlarged and are designed to operate across the slope. Properly constructed sewage lagoons can function adequately. The slope is a severe limitation, but it can be modified by grading. Otherwise, sewage can be piped to adjacent areas where the soils are better suited to lagoons.

Low strength, the slope, frost action, and the shrink-swell potential limit this soil as a site for local roads and streets. Crushed rock or other suitable base material can help to prevent the road damage caused by low strength. Some cutting and filling may be necessary because of the slope. Otherwise, the roads should be designed so that they conform to the natural slope of the land. A drainage system that includes roadside ditches and culverts can help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IVe. The woodland ordination symbol is 3A.

22E2—Gara clay loam, 14 to 20 percent slopes, eroded. This moderately steep, moderately well drained soil is on upland side slopes adjacent to stream channels and flood plains. Water erosion has removed some of the original surface layer. The remaining surface soil has been mixed with the upper part of the subsoil by tillage. Individual areas are irregular in shape and range from about 5 to 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable clay loam about 6 inches thick. The subsoil is dark yellowish brown, firm clay loam about 36 inches thick. It is mottled in the lower part. The substratum to a depth of 60 inches or more is yellowish brown, mottled, firm clay loam. In some areas the soil is strongly sloping or is steep and very steep. In places the depth to calcareous clay loam is less than 36 inches. In a few uneroded areas, the dark surface layer is loam.

Included with this soil in mapping are a few small areas of the moderately deep, moderately steep to very steep Vanmeter soils on convex side slopes. Also included are soils on short, steep slopes that parallel stream channels and flood plains. Included soils make up less than 5 percent of the unit.

Permeability is moderately slow in the Gara soil, and surface runoff is rapid. Available water capacity is high. Natural fertility and organic matter content are low. The surface layer is sticky when wet. The shrink-swell potential of the subsoil is moderate.

Many areas are used for hay or pasture. Some are used as woodland. This soil is too steep for use as cropland and should be tilled only when pasture seeding is needed.

A few areas support native hardwoods. This soil is suited to trees. The hazard of water erosion and the equipment limitation are management concerns. Constructing logging roads and skid trails on the contour minimizes the steepness and length of slope and the concentration of water. In the steepest areas the logs should be yarded uphill to logging roads and skid trails. Seeding of disturbed areas may be necessary after harvesting is completed. Protection from fire and grazing helps to ensure an adequate ground cover for erosion control and for regeneration of the stand.

Growing grasses and legumes for pasture and hay is effective in controlling water erosion. This soil is well suited to birdsfoot trefoil, red clover, reed canarygrass, and tall fescue. It is moderately well suited to alfalfa, orchardgrass, and smooth brome. It is well suited to switchgrass and moderately well suited to most other warm-season grasses. Water erosion during seedbed preparation is the main problem. Timely seedbed preparation helps to ensure a good ground cover. The seedbed should be prepared on the contour. Overgrazing should be avoided. Measures that maintain or improve the organic matter content and fertility and control brush are necessary in existing stands of grass. A few areas have gullies, which should be reshaped and reseeded to grasses.

This soil is suited to building site development and onsite waste disposal if proper design and installation procedures are used. Basement walls, foundations, and footings for small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the subsoil. Dwellings should be designed so that they conform to the natural slope of the land. Otherwise, grading is needed to modify the slope. If the more sloping areas are exposed when a building site is leveled, special management is needed to establish a vegetative cover and divert runoff away from the foundation.

Because of the moderately slow permeability and the slope, septic tank absorption fields generally do not function adequately unless they are enlarged and are designed to operate across the slope. Properly constructed sewage lagoons can function adequately. The slope is a severe limitation, but it can be modified by grading. Otherwise, sewage can be piped to adjacent areas where the soils are better suited to lagoons.

Low strength, the slope, frost action, and the shrink-swell potential limit this soil as a site for local roads and streets. Crushed rock or other suitable base material can help to prevent the road damage caused by low strength. Some cutting and filling may be necessary because of the slope. Otherwise, the roads should be designed so that they conform to the natural slope of the land. A drainage system that includes roadside ditches and culverts can help to prevent the damage caused by frost action and by shrinking and swelling of the soil.

The land capability classification is VIe. The woodland ordination symbol is 3R.

23B—Armstrong loam, 2 to 5 percent slopes. This gently sloping, somewhat poorly drained soil is on narrow ridges in the uplands. Individual areas typically are long and narrow and range from about 5 to more than 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable loam about 8 inches thick. The subsoil is about 44 inches thick. In sequence downward, it is dark yellowish brown, friable clay loam; dark brown, mottled, firm clay loam; strong brown, mottled, firm and very firm clay; and yellowish brown, mottled, firm clay loam. The substratum to a depth of 60 inches or more is yellowish brown, mottled, firm clay loam. In some eroded areas the surface layer is clay loam. It has been thinned by water erosion or has been mixed with the subsoil by tillage. In places the surface soil and subsoil have a lower content of sand and pebbles.

Permeability is slow. Surface runoff is medium. Available water capacity is moderate. Natural fertility is medium, and organic matter content is moderate. The surface layer is friable and can be easily tilled within a moderate range in moisture content. The shrink-swell potential of the subsoil is high. A perched water table is at a depth of 1 to 3 feet during most winter and spring months.

Most areas are used for cultivated crops, hay, or pasture. Some areas are used as woodland. This soil is suited to corn, soybeans, grain sorghum, and small grain. Water erosion is a hazard if the soil is used for cultivated crops. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is effective in controlling water erosion. This soil is well suited to ladino clover. It is moderately well suited to birdsfoot trefoil, tall fescue, big bluestem, and switchgrass. It is moderately suited to alfalfa, red clover, orchardgrass, and smooth brome. Water-tolerant species grow best. Water erosion during seedbed preparation is the main problem. Timely tillage and a quickly established ground cover help to prevent excessive soil loss.

A few small areas support native hardwoods. This soil is suited to trees. Seedling mortality and windthrow are the main problems. Planting container-grown nursery stock can increase seedling survival rates. The stands should be thinned less intensively and more frequently than stands in areas where windthrow is less likely.

This soil is suited to building site development and certain onsite waste disposal systems. The high shrink-swell potential and the wetness are limitations on sites for dwellings and small commercial buildings. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling of the soil. Installing drainage tile around footings helps to prevent the damage caused by excessive wetness. Adequate reinforcement steel, expansion joints, and a sand or gravel base for sidewalks and driveways can help to prevent the damage caused by shrinking and swelling and by frost action. The soil generally is unsuitable as a site for septic tank absorption fields because of the wetness and the slow permeability. Properly designed sewage lagoons can function adequately. Leveling of the lagoon site may be necessary.

Low strength, the high shrink-swell potential, the wetness, and the potential for frost action limit this soil as a site for local roads and streets. Strengthening the base material with crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads so that they shed water and providing adequate roadside ditches and culverts minimize the damage caused by shrinking and swelling, wetness, and frost action.

The land capability classification is IIe. The woodland ordination symbol is 3C.

23C—Armstrong loam, 5 to 9 percent slopes. This moderately sloping, somewhat poorly drained soil is on ridges and side slopes in the uplands near rivers, large streams, and their tributaries. Individual areas are irregular in shape and range from about 5 to 80 acres in size.

Typically, the surface layer is very dark grayish brown, friable loam about 8 inches thick. The subsurface layer is dark brown, friable loam about 3 inches thick. The subsoil is about 31 inches thick. It is mottled and firm. The upper part is dark yellowish brown clay loam, the next part is dark brown and yellowish brown clay, and the lower part is strong brown clay loam. The substratum to a depth of 60 inches is strong brown, mottled, firm clay loam. In some eroded areas the surface layer is clay loam. It has been thinned by water erosion or has been mixed with the subsoil by tillage. In places the surface layer and subsoil have a lower content of sand and pebbles.

Included with this soil in mapping are a few small areas of the moderately well drained Gara soils. These soils generally are on the lower, steeper side slopes. They make up about 5 percent of the unit.

Permeability is slow in the Armstrong soil. Surface runoff is medium. Available water capacity is moderate. Natural fertility is medium, and organic matter content is moderate. The surface layer is friable and can be easily tilled within a moderate range in moisture content. The shrink-swell potential of the subsoil is high. A perched water table is at a depth of 1 to 3 feet during most winter and spring months.

Most areas are used for cultivated crops, hay, or pasture. Some areas are used as woodland. This soil is suited to corn, soybeans, grain sorghum, and small grain. Water erosion is a hazard if the soil is used for cultivated crops. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is effective in controlling water erosion. This soil is well suited to ladino clover. It is moderately well suited to birdsfoot trefoil, tall fescue, big bluestem, and switchgrass. It is moderately suited to alfalfa, red clover, orchardgrass, and smooth brome. Water-tolerant species grow best. Water erosion during seedbed preparation is the main problem. Timely tillage and a quickly established ground cover help to prevent excessive soil loss.

A few small areas support native hardwoods. This soil is suited to trees. Seedling mortality and windthrow are the main problems. Planting container-grown nursery stock can increase seedling survival rates. The stands should be thinned less intensively and more frequently than stands in areas where windthrow is less likely.

This soil is suited to building site development and certain onsite waste disposal systems. The high shrink-swell potential and the wetness are limitations on sites for dwellings and small commercial buildings. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the structural damage caused by shrinking and swelling of the soil. Installing drainage tile around footings helps to prevent the damage caused by excessive wetness. Adequate reinforcement steel, expansion joints, and a sand or gravel base for sidewalks and driveways can help to prevent the damage caused by shrinking and swelling and by frost action. The soil generally is unsuitable as a site for septic tank absorption fields because of the wetness and the slow permeability. Properly designed sewage lagoons can function adequately. Leveling of the lagoon site may be necessary.

Low strength, the high shrink-swell potential, the wetness, and the potential for frost action limit this soil as a site for local roads and streets. Strengthening the base material with crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads so that they shed water and providing adequate roadside ditches and culverts minimize the damage caused by shrinking and swelling, wetness, and frost action.

The land capability classification is IIIe. The woodland ordination symbol is 3C.

24B2—Armstrong clay loam, 2 to 5 percent slopes, eroded. This gently sloping, somewhat poorly drained soil is on narrow ridges and the upper side slopes in the uplands. Water erosion has removed some of the original surface layer. The remaining surface soil has been mixed with the upper part of the subsoil by tillage. Individual areas typically are long and narrow and range from about 5 to more than 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable clay loam about 6 inches thick. The subsoil is about 50 inches thick. The upper part is dark yellowish brown, friable clay loam; the next part is strong brown, mottled, firm and very firm clay loam and clay; and the lower part is yellowish brown, mottled, firm clay loam. The substratum to a depth of 70 inches or more also is yellowish brown, mottled, firm clay loam. In some places the dark surface layer is loam 7 to 9 inches thick. In other places the soil is so eroded that most of the present surface layer is subsoil material. In a few areas the surface layer and subsoil have a lower content of sand and pebbles.

Permeability is slow. Surface runoff is medium. Available water capacity is moderate. Natural fertility and organic matter content are low. The surface layer is sticky when wet and can be easily tilled only within a somewhat narrow range in moisture content. The shrink-swell potential of the subsoil is high. A perched water table is at a depth of 1 to 3 feet during most winter and spring months.

Most areas are used for cultivated crops, hay, or pasture. Some areas are used as woodland. Cultivated crops and small grain are suitable if they are grown on a limited basis. Further water erosion is a serious hazard if the soil is used for cultivated crops. A combination of conservation practices helps to prevent excessive soil loss. No-till farming and other kinds of conservation tillage leave a protective amount of crop residue on the surface after planting. Many areas are smooth enough and large enough to be terraced and farmed on the contour. If exposed by terracing, the clayey subsoil cannot be easily tilled, is low in fertility, and has a low available water capacity. As a result, special management may be needed. The exposed subsoil can be covered with topsoil removed from adjacent areas under construction. Contour stripcropping provides permanent strips of grasses or legumes. These strips are alternated with row crops, which are planted on the contour. The grasses and legumes minimize water erosion. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is effective in controlling water erosion. This soil is well suited to ladino clover. It is moderately well suited to birdsfoot trefoil, tall fescue, big bluestem, and switchgrass. It is moderately suited to alfalfa, red clover, orchardgrass, and smooth brome. Water-tolerant species grow best. Water erosion during seedbed preparation is the main problem. Timely tillage and a quickly established ground cover help to prevent excessive soil loss.

A few small areas support native hardwoods. The soil is suited to trees. Seedling mortality and windthrow are the main problems. Planting container-grown nursery stock can increase seedling survival rates. The stands should be thinned less intensively and more frequently than stands in areas where windthrow is less likely.

This soil is suited to building site development and certain onsite waste disposal systems. The high shrink-swell potential and the wetness are limitations on sites for dwellings and small commercial buildings. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the structural damage caused by shrinking and swelling of the soil. Installing drainage tile around footings helps to prevent the damage caused by excessive wetness. Adequate reinforcement steel, expansion joints, and a sand or gravel base for sidewalks and driveways can help to prevent the damage caused by shrinking and swelling and by frost action. The soil generally is unsuitable as a site for septic tank absorption fields because of the wetness and the slow permeability. Properly designed sewage lagoons can function adequately. Leveling of the lagoon site may be necessary.

Low strength, the high shrink-swell potential, the wetness, and the potential for frost action limit this soil as a site for local roads and streets. Strengthening the base material with crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads so that they shed water and providing adequate roadside ditches and culverts minimize the damage caused by shrinking and swelling, wetness, and frost action.

The land capability classification is IIIe. The woodland ordination symbol is 3C.

24C2—Armstrong clay loam, 5 to 9 percent slopes, eroded. This moderately sloping, somewhat poorly drained soil is on side slopes in the uplands. Water erosion has removed some of the original surface layer. The remaining surface soil has been mixed with the upper part of the subsoil by tillage. Individual areas are irregular in shape and range from about 5 to more than 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable clay loam about 6 inches thick. The subsoil is about 48 inches thick. It is mottled. The upper part is brown, firm clay loam, and the lower part is yellowish brown, very firm and firm clay. The substratum to a depth of 60 inches or more is yellowish brown, mottled, firm clay loam. In some areas the dark surface layer is loam 7 to 9 inches thick. In a few areas the soil is so eroded that most of the present surface layer is subsoil material. In places the surface layer and subsoil have a lower content of sand and pebbles.

Included with this soil in mapping are a few small areas of the moderately well drained Gara soils. These soils generally are on the lower, steeper side slopes. They make up about 5 percent of the unit.

Permeability is slow in the Armstrong soil. Surface runoff is rapid. Available water capacity is moderate. Natural fertility and organic matter content are low. The surface layer is sticky when wet and can be easily tilled only within a somewhat narrow range in moisture content. The shrink-swell potential of the subsoil is high. A perched water table is at a depth of 1 to 3 feet during most winter and spring months.

Most areas are used for cultivated crops, hay, or pasture. Some areas are used as woodland. Cultivated crops and small grain are suitable if they are grown on a limited basis. Further water erosion is a serious hazard if the soil is used for cultivated crops. A combination of conservation practices helps to prevent excessive soil loss. No-till farming and other kinds of conservation tillage leave a protective amount of crop residue on the surface after planting. Many areas are smooth enough and large enough to be terraced and farmed on the contour. If exposed by terracing, the clayey subsoil cannot be easily tilled, is low in fertility, and has a low available water capacity. As a result, special management may be needed. The exposed subsoil can be covered with topsoil removed from adjacent areas under construction. Contour stripcropping provides permanent strips of grasses or legumes. These strips are alternated with row crops, which are planted on the contour. The grasses and legumes minimize water erosion. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is effective in controlling water erosion. This soil is well suited to ladino clover. It is moderately well suited to birdsfoot trefoil, tall fescue, big bluestem, and switchgrass. It is moderately suited to alfalfa, red clover, orchardgrass, and smooth brome. Water-tolerant species grow best. Water erosion during seedbed preparation is the main problem. Timely tillage and a quickly established ground cover help to prevent excessive soil loss.

A few small areas support native hardwoods. The soil is suited to trees. Seedling mortality and windthrow are the main problems. Planting container-grown nursery stock can increase seedling survival rates. The stands should be thinned less intensively and more frequently than stands in areas where windthrow is less likely.

This soil is suited to building site development and certain onsite waste disposal systems. The high shrink-swell potential and the wetness are limitations on sites for dwellings and small commercial buildings. Footings, foundations, and basement walls should be constructed with reinforced concrete and backfilled with sand or gravel. These measures help to prevent the structural damage caused by shrinking and swelling of the soil. Installing drainage tile around footings helps to prevent the damage caused by excessive wetness. Adequate reinforcement steel, expansion joints, and a sand or gravel base for sidewalks and driveways can help to prevent the damage caused by shrinking and swelling and by frost action. The soil generally is unsuitable as a site for septic tank absorption fields because of the wetness and the slow permeability. Properly designed sewage lagoons can function adequately. Leveling of the lagoon site may be necessary.

Low strength, the high shrink-swell potential, the wetness, and the potential for frost action limit this soil as a site for local roads and streets. Strengthening the base material with crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads so that they shed water and providing adequate roadside ditches and culverts minimize the damage caused by shrinking and swelling, wetness, and frost action.

The land capability classification is IIIe. The woodland ordination symbol is 3C.

25B—Pershing silt loam, 2 to 5 percent slopes. This gently sloping, somewhat poorly drained soil is on narrow, high terraces and on the narrow tops and upper side slopes of ridges in the uplands. Individual areas are irregular in shape and range from about 5 to 100 acres in size.

Typically, the surface layer is very dark gray, friable silt loam about 7 inches thick. The subsurface layer is dark grayish brown, friable silt loam about 6 inches thick. The subsoil to a depth of 60 inches or more is mottled. It is dark grayish brown, firm silty clay loam in the upper part; grayish brown, brown, and yellowish brown, very firm silty clay in the next part; and grayish brown and gray, firm silty clay loam in the lower part. In some areas the surface layer is silty clay loam. It has been thinned by erosion or has been mixed with the subsoil by tillage. In some places the subsoil has more sand and pebbles. In other areas the upper part of the subsoil has more clay.

Permeability is slow. Surface runoff is medium. Available water capacity is high. Natural fertility is medium. Organic matter content is moderate. The surface layer is friable and can be easily tilled within a moderate range in moisture content. The shrink-swell potential of the subsoil is high. A perched water table is at a depth of 2 to 4 feet during most winter and spring months.

Most areas are used for cultivated crops, hay, or pasture. Some areas are used as woodland. This soil is suited to corn, soybeans, grain sorghum, and small grain. Water erosion is a hazard if the soil is used for cultivated crops. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is effective in controlling water erosion. This soil is well suited to ladino clover. It is moderately well suited to birdsfoot trefoil, tall fescue, big bluestem, and switchgrass. It is moderately suited to alfalfa, red clover, orchardgrass, and smooth brome. Water-tolerant species grow best. Water erosion during seedbed preparation is the main problem. Timely tillage and a quickly established ground cover help to prevent excessive soil loss.

A few small areas support native hardwoods. This soil is suited to trees. Seedling mortality and windthrow are the main problems. Planting container-grown nursery stock can increase seedling survival rates. The stands should be thinned less intensively and more frequently than stands in areas where windthrow is less likely.

This soil is suited to building site development and certain onsite waste disposal systems. The high shrink-swell potential and the wetness are limitations on sites for dwellings and small commercial buildings. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the structural damage caused by shrinking and swelling of the soil. Installing drainage tile around footings helps to prevent the damage caused by excessive wetness. Adequate reinforcement steel, expansion joints, and a sand or gravel base for sidewalks and driveways can help to prevent the damage caused by shrinking and swelling and by frost action. The soil generally is unsuitable as a site for septic tank absorption fields because of the wetness and the slow permeability. Properly designed sewage lagoons can function adequately. Leveling of the lagoon site may be necessary.

Low strength, the high shrink-swell potential, the wetness, and the potential for frost action limit this soil as a site for local roads and streets. Strengthening the base material with crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads so that they shed water and providing adequate roadside ditches and culverts minimize the damage caused by shrinking and swelling, wetness, and frost action.

The land capability classification is IIIe. The woodland ordination symbol is 3C.

26B2—Pershing silty clay loam, 2 to 5 percent slopes, eroded. This gently sloping, somewhat poorly drained soil is on narrow, high terraces and on the narrow tips and upper side slopes of ridges in the uplands. Water erosion has removed some of the original surface layer. The remaining surface soil has been mixed with the upper part of the subsoil by tillage. Individual areas are irregular in shape and range from about 5 to 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 7 inches thick. The subsoil to a depth of 60 inches or more is mottled silty clay loam and silty clay. The upper part is brown and firm, and in the lower part is grayish brown and is firm and very firm. In some areas the surface layer is silt loam. In a few areas the soil has a subsurface layer of lighter colored silt loam. In some places the soil is so eroded that most of the present surface layer is subsoil material. In other places the subsoil has more clay.

Permeability is slow. Surface runoff is medium. Available water capacity is high. Natural fertility is medium. Organic matter content is low. The surface layer is sticky when wet and can be easily tilled only within a somewhat narrow range in moisture content. The shrink-swell potential of the subsoil is high. A perched water table is at a depth of 2 to 4 feet during most winter and spring months.

Most areas are used for cultivated crops, hay, or pasture. A few areas are used as woodland. This soil is suited to corn, soybeans, grain sorghum, and small grain. Further water erosion is a serious hazard if the soil is used for cultivated crops. A combination of conservation practices helps to prevent excessive soil loss. No-till and other kinds of conservation tillage leave a protective amount of crop residue on the surface after planting. Many areas are smooth enough and large enough to be terraced and farmed on the contour. If exposed by terracing, the clayey subsoil cannot be easily tilled, is low in fertility, and has a low available water capacity. As a result, special management may be needed. The exposed subsoil can be covered with topsoil removed from adjacent areas under construction. Contour stripcropping provides permanent strips of grasses or legumes. These strips are alternated with row crops, which are planted on the contour. The grasses and legumes minimize water erosion. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is effective in controlling water erosion. This soil is well suited to ladino clover. It is moderately well suited to birdsfoot trefoil, tall fescue, big bluestem, and switchgrass. It is moderately suited to alfalfa, red clover, orchardgrass, and smooth brome. Water-tolerant species grow best. Water erosion during seedbed preparation is the main management problem. Timely tillage and a quickly established ground cover help to prevent excessive soil loss.

A few small areas support native hardwoods. This soil is suited to trees. Seedling mortality and windthrow are the main problems. Planting container-grown nursery stock can increase seedling survival rates. The stands should be thinned less intensively and more frequently than stands in areas where windthrow is less likely.

This soil is suited to building site development and certain onsite waste disposal systems. The high shrink-swell potential and the wetness are limitations on sites for dwellings and small commercial buildings. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the structural damage caused by shrinking and swelling of the soil. Installing drainage tile around footings helps to prevent the damage caused by excessive wetness. Adequate reinforcement steel, expansion joints, and a sand or gravel base for sidewalks and driveways can help to prevent the damage caused by shrinking and swelling and by frost action. The soil generally is unsuitable as a site for septic tank absorption fields because of the wetness and the slow permeability. Properly designed sewage lagoons can function adequately. Leveling of the lagoon site may be necessary.

Low strength, the high shrink-swell potential, the wetness, and the potential for frost action limit this soil as a site for local roads and streets. Strengthening the base material with crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads so that they shed water and providing adequate roadside ditches and culverts minimize the damage caused by shrinking and swelling, wetness, and frost action.

The land capability classification is IIIe. The woodland ordination symbol is 3C.

33F—Vanmeter flaggy silty clay loam, 9 to 40 percent slopes. This moderately deep, strongly sloping to very steep, moderately well drained soil is on side slopes in the uplands adjacent to the larger streams, rivers, and their tributaries. Individual areas typically are long and narrow and range from about 5 to more than 500 acres in size.

Typically, the surface layer is dark grayish brown, friable flaggy silty clay loam about 6 inches thick. The subsoil is firm silty clay about 26 inches thick. The upper part is dark grayish brown, grayish brown, and light olive brown and the lower part is multicolored. Weathered bedrock is at a depth of about 32 inches or more. In some areas the depth to bedrock is less than 20 inches. In a few areas it is more than 40 inches. In places the surface layer is flaggy silt loam, silt loam, or silty clay loam.

Included with this soil in mapping are a few small areas of Armstrong, Gara, and Pershing soils. These deep soils are on slopes above the Vanmeter soil. Also included are a few small rocky areas and some bedrock outcrops. Inclusions make up about 15 percent of the unit.

Permeability is very slow in the Vanmeter soil. Surface runoff is rapid. Available water capacity is moderate. Natural fertility and organic matter content are low. The content of flaggy limestone is 0 to more than 15 percent in the upper 20 inches of the soil. The shrink-swell potential of the subsoil is high.

Most areas support native hardwoods. Some areas are used for pasture. This soil is suited to trees. Water erosion is a hazard. The use of equipment is limited because of the slope, rock fragments, and rock outcrops. Seedling mortality and the windthrow hazard are management concerns. Locating logging roads and skid trails on the contour minimizes the steepness and length of slopes and the concentration of water. In the steepest areas the logs should be yarded uphill to logging roads and skid trails. Seeding of disturbed areas may be necessary after harvesting is completed. Planting container-grown nursery stock increases seedling survival rates. The stands should be thinned less intensively and more frequently than stands in areas where windthrow is less likely. Protecting the woodland from fire and grazing helps to ensure an adequate ground cover and regeneration. Expected production of commercial timber is low and might not justify the management required. The included deep soils are more productive than the Vanmeter soil. Onsite investigation is needed to determine the feasibility of intensive timber management.

Growing grasses and legumes for pasture is effective in controlling water erosion. This soil is moderately well suited to birdsfoot trefoil, lespedeza, red fescue, big and little bluestem, and indiangrass. It is moderately suited to most legumes and cool-season grasses. Caution is needed when machinery is operated because bedrock outcrops and flagstones are on the surface or in the upper soil layers. Drought-tolerant, shallow-rooted species grow best. Water erosion during seedbed preparation is a problem. Timely seedbed preparation helps to ensure a good ground cover. Overgrazing should be avoided. Measures that maintain fertility and control brush are necessary in existing stands of grass.

This soil generally is unsuited to building site development and onsite waste disposal because of the slope, the depth to bedrock, the high shrink-swell potential, seepage, and the very slow permeability. With extensive site preparation, however, the soil can be used for low-density building site development. The cost of preparing the site for construction is high. Soils that are better suited to these uses generally are nearby.

The land capability classification is VIIe. The woodland ordination symbol is 2R.

45—Humeston silt loam. This nearly level, poorly drained soil is in the higher areas on flood plains. It is occasionally flooded. Individual areas are irregular in shape and range from about 20 to more than 100 acres in size.

Typically, the surface layer is very dark gray and black, friable silt loam about 13 inches thick. The subsurface layer is dark gray, friable silt loam about 7 inches thick. The subsoil extends to a depth of 60 inches or more. It is firm. The upper part is very dark gray silty clay loam, the next part is black silty clay, and the lower part is very dark gray, mottled silty clay loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Vesser soils. These soils are in positions on the landscape similar to those of the Humeston soil. They make up less than 5 percent of the unit.

Permeability is very slow in the Humeston soil. Surface runoff is slow. Available water capacity and natural fertility are high. Organic matter content is moderate. The surface layer is friable and can be easily tilled within a moderate range in moisture content. The shrink-swell potential of the subsoil is high. A seasonal high water table is at the surface or within a depth of 1 foot during extended wet periods.

Most areas are used for cultivated crops. Some areas are used for hay or pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain. The occasional flooding and the wetness are the main problems. Surface drainage can be improved by land grading or surface ditches. Diversions help to protect the soil against runoff from the uplands. Levees or structures that retard floodwater minimize the crop damage or loss caused by flooding. Deep tillage in fall improves tilth and facilitates early spring planting. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to pasture but is poorly suited to hay. It is best suited to water-tolerant, shallow-rooted species. It is moderately well suited to reed canarygrass and moderately suited to birdsfoot trefoil, ladino clover, and bluegrass. The wetness and the flooding are the main problems. They should be considered when a grazing system is designed. A seedbed can be easily prepared only during dry periods. A surface drainage system is beneficial, especially if the deeper rooted species are grown.

This soil generally is unsuited to building site development. Better suited soils generally are nearby.

The land capability classification is IIw. No woodland ordination symbol is assigned.

50A—Landes fine sandy loam, 0 to 3 percent slopes. This nearly level and gently sloping, well drained soil is on slight rises on the flood plains along rivers and the larger streams. It is occasionally flooded. Individual areas are round or oval and range from about 5 to 50 acres in size.

Typically, the surface layer is very dark grayish brown, friable fine sandy loam about 7 inches thick. The subsurface layer is dark brown, friable fine sandy loam about 6 inches thick. The subsoil is about 19 inches thick. It is very friable. The upper part is brown fine sandy loam, and the lower part is dark yellowish brown loamy fine sand. The substratum to a depth of 60 inches or more is loose fine sand. It is yellowish brown in the upper part and stratified yellowish brown and pale brown in the lower part.

Included with this soil in mapping are a few small areas of soils that are finer textured than the Landes soil. Also included are areas where the slope is more than 3 percent. Included areas make up less than 5 percent of the unit.

Permeability is moderately rapid in the upper part of the Landes soil and rapid in the lower part. Surface runoff is slow. Available water capacity is moderate. Natural fertility is high, and organic matter content is low. The surface layer is friable and can be easily tilled throughout a wide range in moisture content.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, grain sorghum, and small grain. Summer droughtiness is the main problem. Drought-tolerant species should be selected for planting. Minor crop damage can be expected in some years because of the flooding.

This soil is suited to pasture. It is well suited to ladino clover, tall fescue, and bermudagrass. It is moderately well suited to red clover, big bluestem, and indiangrass. It is moderately suited to alfalfa. The flooding and the droughtiness are problems. The flooding is usually of brief duration. The species that are tolerant of flooding and drought grow best. The texture of the surface layer allows for easy seedbed preparation.

This soil is suited to trees. No major hazards or limitations affect planting or harvesting.

This soil generally is unsuited to building site development and onsite waste disposal because of the flooding. Soils that are better suited to these uses generally are nearby.

The land capability classification is IIw. The woodland ordination symbol is 10A.

51—Fatima silt loam. This nearly level, moderately well drained soil is on flood plains along medium and small streams. It is occasionally flooded. Individual areas typically are long and are narrow or moderately wide. They range from about 50 to more than 500 acres in size. Most are several hundred acres in size.

Typically, the surface soil is very dark gray, friable silt loam about 14 inches thick. The subsoil is dark grayish brown and brown, mottled, friable silt loam about 41 inches thick. The substratum to a depth of 68 inches or more is dark grayish brown, mottled, friable silt loam. In some areas the dark surface soil is less than 9 inches thick. In other areas the subsoil is grayer.

Included with this soil in mapping are areas of streambanks and channels. These areas are steeper than the Fatima soil. Also included are small areas of the poorly drained Colo and Zook soils. These soils have a higher content of clay than the Fatima soil. They are in the slightly lower areas between the Fatima soil and the uplands. Included areas make up about 10 to 15 percent of the unit.

Permeability is moderate in the Fatima soil. Surface runoff is medium. Available water capacity is very high. Natural fertility is high. Organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a wide range in moisture content. The shrink-swell potential of the subsoil is low. A seasonal high water table commonly is at a depth of 3 to 5 feet during extended wet periods.

Most areas are used for cultivated crops. Some areas are used for hay or pasture. A few areas are used as woodland. This soil is suited to corn, soybeans, grain sorghum, and small grains. It has no significant limitations if it is protected from flooding. Levees or structures that retard floodwater minimize the crop damage or loss caused by flooding. In a few uneven areas, surface drainage may be a problem. It can be improved by land grading or surface ditches. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to pasture. It is well suited to reed canarygrass. It is moderately well suited to birdsfoot trefoil, red clover, tall fescue, and switchgrass. The occasional flooding can be a problem, but it is usually of brief duration. The texture of the surface layer allows for easy seedbed preparation. A surface drainage system is beneficial, especially if the deeper rooted species are grown.

This soil is suited to trees. No major hazards or limitations affect planting or harvesting.

This soil generally is unsuited to building site development and onsite waste disposal because of the flooding. Soils that are better suited to these uses generally are nearby.

The land capability classification is IIw. The woodland ordination symbol is 5A.

52B—Vigar loam, 2 to 5 percent slopes. This gently sloping, moderately well drained soil is on foot slopes. It is subject to rare flooding. Individual areas typically are long and narrow and range from about 5 to 100 acres in size.

Typically, the surface layer is black, friable loam about 9 inches thick. The subsurface layer is black and very dark brown, friable loam about 21 inches thick. The subsoil to a depth of 74 inches or more is very dark grayish brown, dark brown, and dark yellowish brown, mottled, firm clay loam.

Permeability is moderately slow. Surface runoff is medium. Available water capacity and natural fertility are high. Organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is moderate. A seasonal high water table commonly is at a depth of 2 to 3 feet during extended wet periods.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain. Water erosion is a hazard if the soil is used for cultivated crops. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration. Diversions help to protect the soil against runoff from the uplands.

Growing grasses and legumes for pasture and hay is effective in controlling water erosion. This soil is well suited to ladino clover. It is moderately well suited to birdsfoot trefoil, tall fescue, big bluestem, and switchgrass. It is moderately suited to alfalfa, red clover, orchardgrass, and smooth brome. Water-tolerant species grow best. Water erosion during seedbed preparation is the main problem. Timely tillage and a quickly established ground cover help to prevent excessive soil loss.

This soil generally is unsuited to building site development and onsite waste disposal because of the flooding and the wetness.

The land capability classification is IIe. No woodland ordination symbol is assigned.

54—Zook silty clay loam. This nearly level, poorly drained soil is on flood plains along rivers and large and small streams. It is occasionally flooded. Individual areas are irregular in shape and range from about 5 to more than 400 acres in size.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is about 27 inches thick. It is black. The upper part is friable silty clay loam, and the lower part is firm silty clay. The subsoil is very dark gray, mottled, firm silty clay about 20 inches thick. The substratum to a depth of 60 inches or more is dark gray, mottled, firm silty clay. In some depressional areas the soil is finer textured throughout. In places the subsoil is silty clay loam.

Included with this soil in mapping are small areas of the moderately well drained Nodaway soils along stream channels. These soils have a lower content of clay than the Zook soil. They make up less than 5 percent of the unit.

Permeability is slow in the Zook soil. Surface runoff is very slow. Available water capacity is moderate. Natural fertility and organic matter content are high. The surface layer is sticky when wet and can be easily tilled only within a narrow range in moisture content. The soil becomes cloddy and cannot be easily managed if worked when wet. The shrink-swell potential is high. A seasonal high water table is at the surface or within a depth of 3 feet during extended wet periods.

Most areas are used for cultivated crops. Some areas are used for hay or pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain. The occasional flooding and the wetness are the main problems. Surface drainage can be improved by land grading or surface ditches. Diversions help to protect the soil against runoff from uplands. Levees or structures that retard floodwater minimize the crop damage or loss caused by flooding. Deep tillage in fall improves tilth and facilitates early spring planting. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to pasture but is poorly suited to hay. It is best suited to water-tolerant, shallow-rooted species. It is moderately well suited to reed canarygrass. It is moderately suited to birdsfoot trefoil, ladino clover, and bluegrass. The wetness and the flooding are the main problems. They should be considered when a grazing system is designed. Maintaining stands of desirable species in depressional areas is difficult. A surface drainage system is beneficial, especially if the deeper rooted species are grown.

This soil generally is unsuited to building site development and onsite waste disposal because of the flooding. Soils that are better suited to these uses generally are nearby.

The land capability classification is IIw. No woodland ordination symbol is assigned.

55—Colo silty clay loam. This nearly level, poorly drained soil is on low terraces, alluvial fans, and flood plains along rivers and large streams. It is occasionally flooded. Individual areas are irregular in shape and range from about 5 to more than 100 acres in size.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer also is black, friable silty clay loam. It is about 22 inches thick. The subsoil to a depth of 60 inches or more is firm silty clay loam. The upper part is very dark gray, and the lower part is very dark gray and dark gray and is mottled. In some places the surface layer is silt loam. In other places the subsoil has more clay.

Included with this soil in mapping are a few small areas of the moderately well drained Nodaway soils along stream channels. These soils make up less than 5 percent of the unit.

Permeability is moderate in the Colo soil. Surface runoff is slow. Available water capacity, natural fertility, and organic matter content are high. The surface layer is friable and can be easily tilled within a moderate range in moisture content. The shrink-swell potential is high. A seasonal high water table commonly is at a depth of 1 to 3 feet during extended wet periods.

Most areas are used for cultivated crops. Some areas are used for hay or pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain. The occasional flooding and the wetness are the main problems. Surface drainage can be improved by land grading or surface ditches. Diversions help to protect the soil against runoff from the uplands. Levees or structures that retard floodwater minimize the crop damage or loss caused by flooding. Deep tillage in fall improves tilth and facilitates early spring planting. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to pasture but is poorly suited to hay. It is best suited to water-tolerant, shallow-rooted species. It is moderately suited to reed canarygrass and alsike clover. The wetness and the flooding are the main problems. They should be considered when a grazing system is designed. A seedbed can be easily prepared only during dry periods. A surface drainage system is beneficial, especially if the deeper species are grown.

This soil generally is unsuited to building site development and onsite waste disposal because of the flooding. Soils that are better suited to these uses generally are nearby.

The land capability classification is IIw. No woodland ordination symbol is assigned.

56A—Colo silty clay loam, channeled, 0 to 3 percent slopes. This nearly level and gently sloping, poorly drained soil is in narrow drainageways that dissect and branch into the uplands. It is frequently flooded. Individual areas are long and narrow and range from about 5 to more than 200 acres in size.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is black, friable and firm silty clay loam about 24 inches thick. The subsoil is firm silty clay loam to a depth of 60 inches or more. The upper part is black, the next part is very dark gray and mottled, and the lower part is grayish brown and mottled. In some areas the soil has more clay throughout. In other areas it is dark to a depth of less than 36 inches.

Included with this soil in mapping are areas of streambanks and channels. These areas are steeper than the Colo soil. Also included are some accessible areas where the channels have been straightened. Included areas make up about 10 percent of the unit.

Permeability is moderate in the Colo soil. Surface runoff is slow. Available water capacity, natural fertility, and organic matter content are high. The surface layer is friable and can be easily tilled within a moderate range in moisture content. The shrink-swell potential is high. A seasonal high water table commonly is at a depth of 1 to 3 feet during extended wet periods.

Most areas are used for hay and pasture. Some are used as woodland. A few accessible areas are cultivated along with the adjoining areas.

This soil is suited to pasture. It is best suited to water-tolerant, shallow-rooted species. It is moderately suited to reed canarygrass and alsike clover. Ditchbank erosion, the wetness, and the frequent flooding are the main problems. Also, inaccessibility is a problem in most areas when forage crops are harvested. Reshaping and seeding ditchbanks or building small grade stabilization structures can help to control ditchbank erosion. Surface drainage can be improved by land grading or surface ditches. Diversions help to protect the soil against runoff from the uplands. Levees or structures that retard floodwater minimize the crop damage or loss caused by flooding. Overgrazing of pastures can reduce future production of grasses and legumes and increase the extent of weeds. Timely mowing helps to control undesirable plants and helps to achieve a uniform distribution of grazing. Grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods can improve the pasture.

This soil is suited to trees. Many areas that are inaccessible for farming could support a stand of hardwoods or conifers. The soil also is suitable for the development of openland, woodland, and wetland wildlife habitat. The plants that can withstand wetness are preferable for wildlife food and cover.

This soil generally is unsuited to cultivated crops because most areas are too narrow and too channeled to be readily accessible to large machinery. Many areas are dissected by gullies and by meandering intermittent streams.

This soil generally is unsuited to building site development and onsite waste disposal because of the flooding. Soils that are better suited to these uses generally are nearby.

The land capability classification is Vw. No woodland ordination symbol is assigned.

58—Wabash silty clay. This nearly level or depressional, very poorly drained soil is on flood plains along rivers and large streams. It is occasionally flooded. Individual areas are irregular in shape and range from 10 to more than 100 acres in size.

Typically, the surface soil is black, firm silty clay about 18 inches thick. The subsoil is mottled, very firm silty clay about 37 inches thick. The upper part is black, and the lower part is very dark gray and dark gray. The substratum to a depth of 60 inches or more is gray, mottled, firm silty clay. In some areas the soil has less clay.

Permeability and surface runoff are very slow. Available water capacity is moderate. Natural fertility is medium. Organic matter content is moderate. The surface layer is very sticky when wet and hard when dry. Tilling the soil is somewhat difficult even during periods of optimum moisture content. The shrink-swell potential is very high. A seasonal high water table is at the surface or within a depth of 1 foot during extended wet periods.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to corn, soybeans, and grain sorghum. The occasional flooding and the wetness are severe problems. Levees or structures that retard floodwater minimize the crop damage or loss caused by flooding. Surface drainage can be improved by land grading or surface ditches. Deep tillage in fall improves tilth and facilitates early spring planting. The soil becomes cloddy and cannot be easily managed if worked when wet. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to pasture but is poorly suited to hay. It is best suited to water-tolerant, shallow-rooted species. It is moderately well suited to reed canarygrass and moderately suited to birdsfoot trefoil, ladino clover, and bluegrass. The wetness and the flooding are the main problems. They should be considered when a grazing system is designed. Maintaining stands of desirable species is difficult in depressional areas. A surface drainage system is beneficial, especially if the deeper rooted species are grown.

This soil is suited to trees. The equipment limitation, seedling mortality, and windthrow are the main problems. The trees should be harvested only when the ground is frozen or during extended dry periods. Ridging the soil and planting water-tolerant species on the ridges increase the seedling survival rate. The stands should be thinned less intensively and more frequently than stands in areas where windthrow is less likely.

This soil generally is unsuited to building site development and onsite waste disposal because of the flooding. Soils that are better suited to these uses generally are nearby.

The land capability classification is IIIw. The woodland ordination symbol is 4W.

66—Nodaway silt loam. This nearly level, moderately well drained soil is on flood plains along medium and large streams and rivers. It is occasionally flooded. Individual areas typically are long and are moderately wide or wide. They range from about 20 to more than 1,000 acres in size.

Typically, the surface layer is very dark gray, friable silt loam about 9 inches thick. The substratum to a depth of 60 inches or more is stratified brown, grayish brown, dark grayish brown, and very dark grayish brown, friable silt loam. Some areas are undulating. These areas commonly are remnants of old meandering streams.

Included with this soil in mapping are low areas in the meanders of old stream channels and along straightened channels. Some of these areas are filled with water part or all of the year. The soils in these areas have a surface layer of loam to very fine sandy loam and are underlain by sand. They typically are as much as 10 to 20 feet lower than the adjoining Nodaway soil and are flooded more frequently. Also included are sandy spots, mainly along the Thompson and Weldon Rivers; undulating and steeper areas on streambanks and in channels; and small areas of the poorly drained Colo and Zook soils. Colo and Zook soils have a higher content of clay than the Nodaway soil. They are in the slightly lower areas between the Nodaway soil and the uplands. Included soils make up about 15 percent of the unit.

Permeability is moderate in the Nodaway soil. Surface runoff is slow. Available water capacity is very high. Natural fertility is high. Organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a wide range in moisture content. The shrink-swell potential is moderate. A seasonal high water table commonly is at a depth of 3 to 5 feet during extended wet periods.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, grain sorghum, and small grain. It has no significant limitations if it is protected from flooding. Levees or structures that retard floodwater minimize the crop damage or loss caused by flooding. In a few uneven areas, surface drainage may be a problem. It can be improved by land grading or surface ditches. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Some areas support small stands of native hardwoods. This soil is suited to trees. No major hazards or limitations affect planting or harvesting.

This soil generally is unsuited to building site development and onsite waste disposal because of the flooding. Soils that are better suited to these uses generally are nearby.

The land capability classification is IIw. The woodland ordination symbol is 9A.

67—Vesser silt loam. This nearly level, somewhat poorly drained soil is on flood plains along rivers and streams. It is occasionally flooded. Individual areas are irregular in shape and range from about 10 to more than 200 acres in size.

Typically, the surface layer is black, friable silt loam about 10 inches thick. The subsurface layer is friable silt loam about 18 inches thick. The upper part is very dark gray and the lower part is very dark grayish brown and dark grayish brown. The subsoil to a depth of 60 inches or more is dark grayish brown, mottled, firm silty clay loam. In some areas it has more clay.

Included with this soil in mapping are small areas of the poorly drained Humeston soils. These soils are in positions on the landscape similar to those of the Vesser soil. They make up less than 5 percent of the unit.

Permeability is moderate in the Vesser soil. Surface runoff is slow. Available water capacity and natural fertility are high. Organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a moderately wide range in moisture content. The shrink-swell potential of the subsoil is moderate. A seasonal high water table commonly is at a depth of 1 to 3 feet during extended wet periods.

Most areas are used for cultivated crops. Some areas are used for hay or pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain. The occasional flooding and the wetness are the main problems. Surface drainage can be improved by land grading or surface ditches. Diversions help to protect the soil against runoff from the uplands. Levees or structures that retard floodwater minimize the crop damage or loss caused by flooding. Deep tillage in fall improves tilth and facilitates early spring planting. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to pasture but is poorly suited to hay. It is best suited to water-tolerant, shallow-rooted species. It is moderately suited to reed canarygrass and alsike clover. The wetness and the flooding are the main problems. They should be considered when a grazing system is designed. A seedbed can be easily prepared only during dry periods. A surface drainage system is beneficial, especially if the deeper rooted species are grown.

This soil generally is unsuited to building site development and onsite waste disposal because of the flooding. Soils that are better suited to these uses generally are nearby.

The land capability classification is IIw. No woodland ordination symbol is assigned.

88—Pits, quarries. This map unit consists of open excavations in areas where soil material has been removed and the underlying sand, gravel, or limestone bedrock has been exposed. Areas include both abandoned and active quarries and pits. They range from about 5 to more than 100 acres in size.

A typical quarry has a vertical face or exposure on two or three sides. These exposures are 10 to more than 100 feet high and consist mostly of limestone and lesser amounts of shale. Above the vertical rock face, the overburden is glacial material 1 to 25 feet thick. In some areas 3 to 10 feet of loess overlies the glacial material. The overburden is removed and then is stockpiled in the undisturbed adjacent areas or placed in previously mined pits.

One area of this unit is a sand pit on the west side of the Grand River southwest of Trenton. The sand is removed from sandbars along the channel of the river and then is processed and stockpiled on the adjoining flood plain.

Some areas have been reshaped and reseeded. The restored topsoil is a mixture of the original topsoil, subsoil, and gravelly or rocky material. Tilth is poor, and organic matter content is very low. Most areas are rough and steep and support mainly weeds and brush. Some reclaimed areas are used as pasture. Even if proper reclamation measures are applied, however, most areas are best suited to wildlife habitat or recreational development. Some areas are abandoned deep pits that are filled with water because no drainage outlet is available (fig. 7).

No land capability classification or woodland ordination symbol is assigned.

Prime Farmland

Prime farmland is one of several kinds of important farmlands defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland. The loss of prime farmland to urban and other uses puts pressure on marginal lands, which generally are less productive.

Figure 7.—Abandoned deep pit filled with water.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cropland, pasture, woodland, or other land, but it is not urban or built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slopes range mainly from 0 to 5 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

About 118,570 acres in Grundy County, or 42 percent of the total acreage, meets the soil requirements for prime farmland. Of this acreage, 57,570 acres meets the soil requirements only in areas where the soil is drained. Most of the prime farmland is used for cropland. Areas of prime farmland are throughout the survey area, but most are in associations 1 and 2, which are described under the heading "General Soil Map Units."

The map units in the survey area that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table qualify for prime farmland only in areas where this limitation has been overcome by drainage measures. The need for these measures is indicated after the soil map unit name in table 5. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help to prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

Curt Rockhold, district conservationist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

The potential of the soils in Grundy County for sustained production of food is good. About 42 percent of the county is prime farmland. Only a small percentage of the cropland and pasture is adequately treated to meet conservation needs. The inadequately treated cropland is mostly in upland areas that are being farmed in a manner that causes excessive water erosion. Some of the marginal cropland used for row crops should be converted to pasture and hayland.

The major management needs on the cropland and pasture in the county are measures that control water erosion, reduce wetness, control floodwater, and maintain fertility and tilth.

Water erosion is the major problem on nearly all of the sloping cropland and overgrazed pasture in the county. It is a hazard in areas where the slope is more than 2 percent. Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging on soils that have a clayey subsoil, such as Armstrong, Grundy, Kilwinning, Lamoni, and Pershing soils. Erosion also reduces the productivity of Vanmeter and other soils that tend to be droughty because of bedrock within 3 feet of the surface. Second, water erosion on farmland results in the sedimentation of roadside ditches (fig. 8) and of streams, lakes, and ponds. Control of erosion minimizes this pollution and thus improves the quality of

Figure 8.—Damage to a road and to roadside ditches caused by sedimentation.

water for municipal use, for recreation, and for fish and wildlife.

On clayey spots in many fields, seedbed preparation and tillage are difficult because the original friable surface soil has been removed by erosion. Such spots occur in the eroded areas of Armstrong, Grundy, Lamoni, and Pershing soils.

Erosion-control measures provide a protective plant cover, help to control runoff, and increase the rate of water infiltration. A cropping system that maintains vegetation or crop residue on the surface minimizes erosion and does not reduce the productive capacity of the soils. Growing grasses and legumes for pasture and hay is effective in controlling erosion. Including legumes, such as clover and alfalfa, in the crop rotation improves tilth and helps to provide nitrogen for the following crop.

Terraces reduce the length of slopes and thus help to control runoff and erosion. Conventional broad-base terraces are most practical on the uneroded upland soils that have long, smooth, gently sloping and moderately sloping side slopes. Special construction and management techniques are necessary if terrace systems are to be effective in the steepest areas of Gara and Shelby soils. Constructing narrow-base terraces reduces the gradient of the slope. Constructing conventional terraces increases the gradient and thus makes further erosion-control measures crucial. In areas where these terraces are constructed, cropping systems that provide a substantial vegetative cover are needed to control erosion unless a system of conservation tillage that leaves large amounts of crop residue is applied. Minimizing tillage on the more sloping soils and leaving large quantities of crop residue on the surface increase the rate of water infiltration and reduce the hazards of runoff and water erosion. These measures can be applied on many of the soils in the survey area, but they are less successful on eroded soils that have a clayey surface layer than on other soils. On the Armstrong, Grundy, Lamoni, and Pershing soils, special management is needed in areas where terracing exposes the clayey subsoil.

If the soil is not suitable for terracing or if an individual farmer does not prefer terraces as a conservation practice, other alternatives are available. Contour stripcropping is an example. In areas where this measure is applied, contoured strips of meadow crops are grown in short-term rotations. Such grass or grass-legume strips generally are used for hay. Row crops are planted on the contour in the areas between the strips. The use of stripcropping in the county began in 1979 in Washington Township. Since then, 10 of the 13 townships have farmland on which stripcropping is used as an economical method of controlling erosion. "No-till" is becoming more common in the county. It is effective in controlling erosion on the more sloping soils. It can be used on many soils in the survey area. Special management is needed, however, in severely eroded areas.

Wetness and *flooding* are management concerns on some of the cropland and pasture in Grundy County. Wabash soils naturally are so wet that crop growth usually is retarded during part of the year. Wetness also is a limitation in areas of Colo, Humeston, Vesser, and Zook soils. Land grading or a surface drainage system generally is needed on all of these soils. Occasional flooding can be a problem on Colo, Fatima, Humeston, Landes, Nodaway, Vesser, Wabash, and Zook soils. The flooding usually occurs during the period November through April.

Soil fertility is naturally lower in most of the eroded and moderately deep soils in the county than in other soils. On all soils, however, additional plant nutrients are needed for optimum production. Most of the soils in the county are naturally acid in the upper part of the root zone and require applications of ground limestone to raise the pH sufficiently for the optimum growth of legumes. On all soils, additions of lime and fertilizer should be based on the results of soil tests, on the needs of the crop, and on the desired level of yields. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer and lime to be applied.

Soil tilth is an important factor affecting the germination of seeds and the infiltration of water into the soil. Soils with good tilth are granular and porous.

Most of the uneroded upland soils used for crops in the county have a silt loam or loam surface layer that is dark and is moderate or high in content of organic matter. Tillage and compaction generally weaken the structure of the silt loams and loams. During periods of heavy rainfall, a crust forms on the surface. The crust is hard when dry. As a result, it reduces the rate of water infiltration and increases the runoff rate. Regular additions of crop residue, manure, or other organic material improve soil structure and tilth.

All of the eroded upland soils have a higher content of clay in the surface layer than the uneroded soils. Also, tilth is poorer, infiltration is slower, and runoff is more rapid. Measures that prevent further water erosion are needed on these soils.

Fall tillage is common in the survey area but is a poor conservation practice on most upland soils. Most of the cropland in the uplands consists of sloping soils that are subject to erosion if they are tilled in the fall.

Tilth is a problem in the clayey Zook and Wabash soils, which often stay wet until late in the spring. If they are wet when plowed, these soils tend to be cloddy when dry. Because of the cloddiness, preparing a seedbed is difficult. Fall tillage generally improves tilth in these soils.

Field crops suited to the soils and climate of the survey area include corn, soybeans, and grain sorghum. Winter wheat is the most common close-growing crop. Oats and rye are grown to a lesser extent. Double cropping is beginning to show some promise as an alternative cropping system. Soybeans can be planted directly into wheat stubble. The large amounts of residue on the surface are helpful in protecting the soil against water erosion. The limitations affecting double cropping are the lack of a plentiful water supply and the growing season.

Pasture and hay crops suited to the soils and climate of the survey area include several legumes, cool-season grasses, and warm-season native grasses. Alfalfa and red clover are the most common legumes grown for hay. They also are included in mixtures with bromegrass, orchardgrass, fescue, or timothy grown for hay and pasture. Birdsfoot trefoil is used in mixtures that include bromegrass, orchardgrass, fescue, and bluegrass grown for pasture.

The warm-season native grasses that can be grown in the survey area are big bluestem, little bluestem, indiangrass, and switchgrass. These grasses grow well during the hot summer months. The management techniques differ from those needed in areas of cool-season grasses.

Alfalfa is best suited to deep, moderately well drained soils, such as Gara, Shelby, Fatima, Nodaway, and Vigar soils. The other legumes and all grasses grow well on most of the upland soils in the survey area. Zook, Wabash, and other soils that are occasionally flooded and stay wet for long periods are not suited to some grasses. They are better suited to short-season summer annuals.

The major management concerns on most of the pasture in the county are overgrazing and gully erosion. Grazing should be controlled so that the plants not only survive but also yield the optimum amount of forage. Grazing management that maintains the vigor of the forage plants can help to control runoff and gullying.

Specialty crops, such as sunflowers, fruits, and vegetables, are grown on a small acreage in the survey area. These crops require special equipment, management, and propagation techniques.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations also are considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for woodland and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit *(13)*. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations or hazards that restrict their use.

Class II soils have moderate limitations or hazards that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations or hazards that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations or hazards that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations or hazards that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations or hazards that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations or hazards that nearly preclude their use for commercial crop production.

There are no class I or class VIII soils in Grundy County.

Capability subclasses are soil groups within one class. In this survey area, they are designated by adding a small letter, *e* or *w* to the class numeral, for example, IIe. The letter *e* shows that the main hazard is risk of water erosion unless close-growing plant cover is maintained, and *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage).

Class V contains only the subclass indicated by *w* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in the yields table.

Woodland Management and Productivity

James L. Robinson, forester, Soil Conservation Service, helped prepare this section.

About 5 percent of Grundy County is forested. In many areas the soils formed under prairie vegetation. The soils in the Lamoni-Shelby-Grundy association are examples. Forest vegetation generally grows only along the drainageways or in the steeper areas of this association.

The soils in the Armstrong-Gara-Vanmeter association formed under forest vegetation. This association has the largest acreage of forest in the county. Oak-hickory is the typical forest cover. White oak, northern red oak, and hickories are the dominant species. Black oak, chinkapin oak, shingle oak, basswood, sugar maple, American elm, and black walnut are less extensive species. In some areas these species are dominant because of site factors, such as aspect, and because of the available water capacity of the soil. Past management also influences the species composition of a stand. Many of the timbered sites in this association can respond well to good forest management.

Most of the Zook-Nodaway-Wabash association on bottom land is intensively farmed. The timbered acreage is restricted to odd areas, wet areas, or unprotected areas where frequent flooding limits the suitability for crops. These soils in these areas are highly productive. Timber species vary, depending on soil texture and wetness. Pin oak, silver maple, and green ash grow on the more poorly drained Zook and Wabash soils, while cottonwood, hackberry, and walnut typically grow on the Nodaway soils. Other species include box elder, American elm, black willow, and shellbark hickory. Nodaway soils and the minor Fatima and Landes soils are excellent sites for intensive management of black walnut.

Table 7 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for an indicator tree species. The number indicates the volume, in cubic meters per hectare per year, which the indicator species can produce. The number 1 indicates low potential productivity; 2 and 3, moderate; 4 and 5, moderately high; 6 to 8, high; 9 to 11, very high; and 12 to 39, extremely high. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *R* indicates steep slopes; *X*, stoniness or rockiness; *W*, excess water in or on the soil; *T*, toxic substances in the soil; *D*, restricted rooting depth; *C*, clay in the upper part of the soil; *S*, sandy texture; *F*, a high content of rock fragments in the soil; and *L*, low strength. The letter *A* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: R, X, W, T, D, C, S, F, and L.

In table 7, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Erosion hazard is the probability that damage will occur as a result of site preparation and cutting where the soil is exposed along roads, skid trails, fire lanes, and log-handling areas. Forests that have been burned or overgrazed also are subject to water erosion. Ratings of the erosion hazard are based on the percent of the slope. A rating of *slight* indicates that no particular prevention measures are needed under ordinary conditions. A rating of *moderate* indicates that erosion-control measures are needed in certain silvicultural activities. A rating of *severe* indicates that special precautions are needed to control water erosion in most silvicultural activities.

Equipment limitation reflects the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. The chief characteristics and conditions considered in the ratings are slope, stones on the surface, rock outcrops, soil wetness, and texture of the surface layer. A rating of *slight* indicates that under normal conditions the kind of equipment or season of use is not significantly restricted by soil factors. Soil wetness can restrict equipment use, but the wet period does not exceed 1 month. A rating of *moderate* indicates that equipment use is moderately restricted because of one or more soil factors. If the soil is wet, the wetness restricts equipment use for a period of 1 to 3 months. A rating of *severe* indicates that equipment use is severely restricted either as to the kind of equipment that can be used or the season of use. If the soil is wet, the wetness restricts equipment use for more than 3 months.

Seedling mortality refers to the death of naturally occurring or planted tree seedlings, as influenced by the kinds of soil, soil wetness, or topographic conditions. The factors used in rating the soils for seedling mortality are texture of the surface layer, depth to a seasonal high water table and the length of the period when the water table is high, rock fragments in the surface layer, effective rooting depth, and slope aspect. A rating of *slight* indicates that seedling mortality is not likely to be a problem under normal conditions. Expected mortality is less than 25 percent. A rating of *moderate* indicates that some problems from seedling mortality can be expected. Extra precautions are advisable. Expected mortality is 25 to 50 percent. A rating of *severe* indicates that seedling mortality is a serious problem. Extra precautions are important. Replanting may be necessary. Expected mortality is more than 50 percent.

Windthrow hazard is the likelihood that trees will be uprooted by the wind because the soil is not deep enough for adequate root anchorage. The main restrictions that affect rooting are a seasonal high water table and the depth to bedrock, a fragipan, or other limiting layers. A rating of *slight* indicates that under normal conditions no trees are blown down by the wind. Strong winds may damage trees, but they do not uproot them. A rating of *moderate* indicates that some trees can be blown down during periods when the soil is wet and winds are moderate or strong. A rating of *severe* indicates that many trees can be blown down during these periods.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index* and as a *volume* number. The site index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

The *volume*, a number, is the yield likely to be produced by the most important trees. This number, expressed as cubic feet per acre per year, indicates the amount of fiber produced in a fully stocked, even-aged, unmanaged stand.

The first species listed under *common trees* for a soil is the indicator species for that soil. It is the dominant species on the soil and the one that determines the ordination class.

Trees to plant are those that are suitable for commercial wood production.

Windbreaks and Environmental Plantings

James L. Robinson, forester, Soil Conservation Service, helped prepare this section.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, furnish habitat for wildlife, beautify the area, and reduce home heating costs as much as 25 to 30 percent *(3)*. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

In some areas of the Lamoni-Shelby-Grundy and Armstrong-Gara-Vanmeter associations, farmstead or feedlot windbreaks are needed. Field windbreaks may be needed in areas of the Zook-Nodaway-Wabash and Lamoni-Shelby-Grundy associations. They significantly improve the yields on cropland and tend to moderate the extremes of cold, dry windy conditions and hot, dry windy conditions. In years when these conditions are most severe, field windbreaks have their greatest impact on crop yields.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 8 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 8 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

Ken Kriewitz, wildlife services biologist, Missouri Department of Conservation, helped prepare this section.

Grundy County is in an area of intensive agricultural uses. Most of the land is privately owned and is farmed. Generally, only the owner's families and friends use the private land for outdoor recreational pursuits, such as hunting and fishing. Other than several city parks, Crowder State Park, which is northwest of Trenton, is the only public recreational land in the county. It is a 677-acre park administered by the Department of Natural Resources. A 20-acre lake in the park provides opportunities for swimming. Hiking, bird-watching, picnicking, and camping also are popular outdoor activities in the park.

County residents and others fish the streams in the county. Several small streams and the Thompson and Weldon Rivers are popular fishing waters. Ponds and small lakes also provide opportunities for recreation (fig. 9).

The soils of the survey area are rated in table 9 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation also are important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 9, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils are gently sloping and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Steep slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

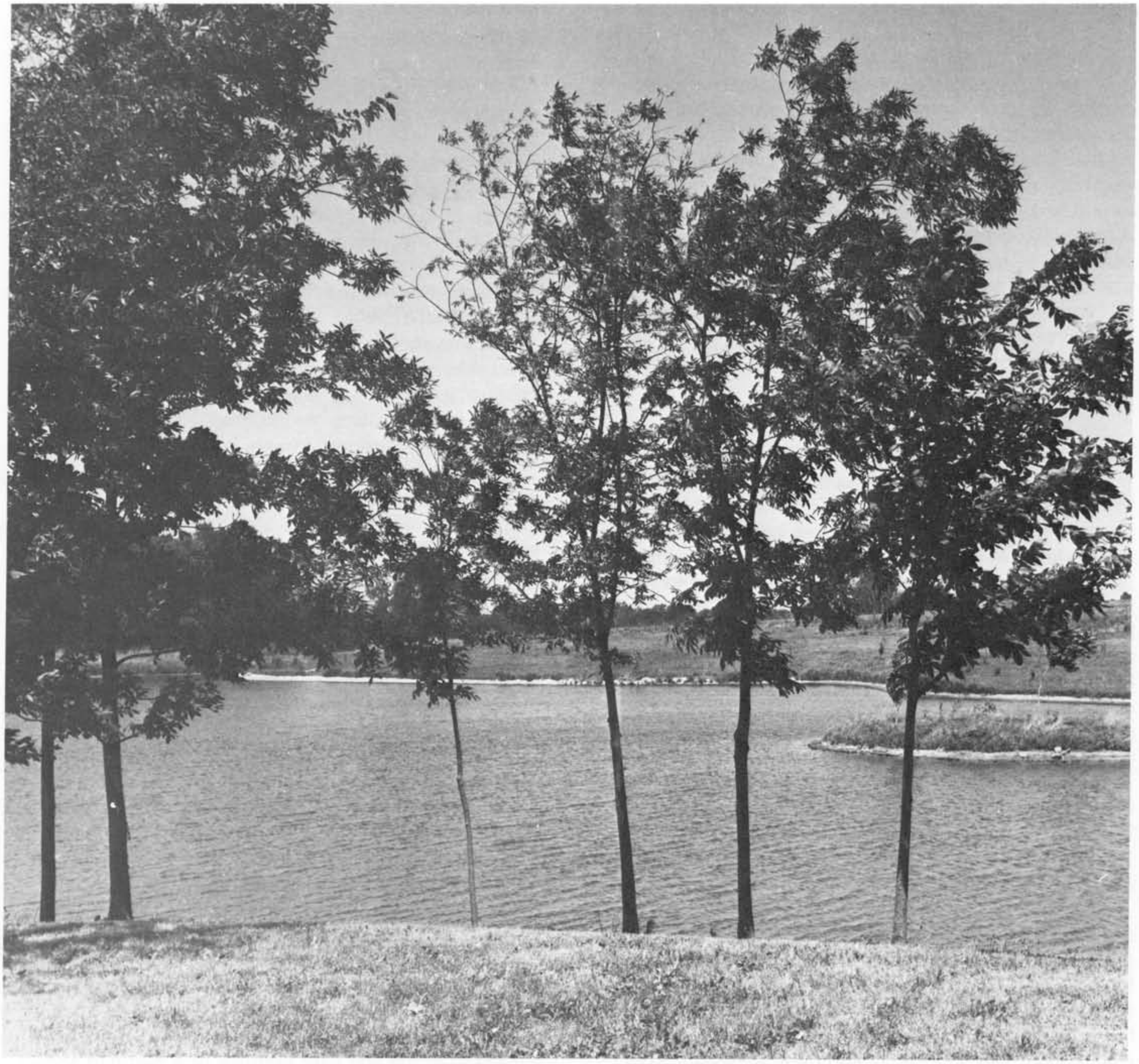


Figure 9.—A small lake in Grundy County.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Ken Kriewitz, wildlife services biologist, Missouri Department of Conservation, helped prepare this section.

Soil is the chief factor determining wildlife populations. Just as the various soils formed under certain plant communities, so have particular wildlife species evolved on specific kinds of soil. Although farming and other land uses generally have disrupted the naturally occurring wildlife habitats, certain wildlife species still primarily inhabit the areas where they evolved.

The two major game animals are white-tailed deer and eastern wild turkey. The deer are throughout the county. Like the turkeys, however, they are most numerous in and around the more wooded parts of the county, which are located in the Armstrong-Gara-Vanmeter association.

The number of squirrels fluctuates, depending on the supply of nuts. The squirrels generally are plentiful in wooded areas. They are most numerous in the areas of the Armstrong-Gara-Vanmeter association. Cottontail rabbits populate the entire county. Brush-covered draws near grass-legume meadows provide ideal habitat for the rabbits. Both species are actively hunted annually.

Ring-necked pheasants generally inhabit the northern part of the county. Pheasant populations are fairly stable and are generally expanding southward. Pheasants prefer relatively open land interspersed with cropland and grassland. The Lamoni-Shelby-Grundy association has the best pheasant population.

The number of bobwhite quail fluctuates widely. Several factors influence these fluctuations. The general scarcity of a protective woody cover is the primary problem. Severe winters accentuate the scarcity of the protective cover and thus decrease the quail population. Good summer nesting successes coupled with mild winters increase the population. The quail prefer diverse areas where land uses intermingle. Field borders, brush-covered draws, and cropland and woodland borders are the preferred habitat. All of the soil associations in the county are inhabited by some quail.

Nearly all of the fur-bearing species that are common in Missouri inhabit Grundy County. Opossum, muskrat, mink, red fox, beaver, raccoon, badger, coyote, weasel, and skunk are fairly common and are pursued by trappers and hunters. Most of these species are in areas throughout the county where the habitat is suitable.

Waterfowl pass through the county during migratory flights. Duck hunting is popular on the numerous ponds in the county. Some ducks are hunted in local areas, such as old stream meanders of the channelized Thompson River. Generally, hunting opportunities are limited.

Nongame species reside in or pass through the county. Various small mammals, reptiles, and amphibians live in preferred habitat throughout the county.

Fishing waters are fairly plentiful in the county. Nearly every farm has one or two stocked ponds. Most of the streams in the county are inhabited by fish. A 20-acre lake in Crowder State Park is stocked with crappie, bass, bluegill, channel catfish, and bullheads.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 10, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture also are considerations. Examples of grain and seed crops are corn, winter wheat, oats, millet, soybeans, and grain sorghum.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture also are considerations. Examples of grasses and legumes are bluegrass, switchgrass, orchardgrass, indiangrass, clover, alfalfa, birdsfoot trefoil, and crownvetch.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture also are considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, pokeweed, foxtail, croton, and partridge pea.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwoods and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, sweetgum, apple, hawthorn, dogwood, hickory, blackberry, wild plum, sumac, persimmon, and sassafras. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are autumn olive, crabapple, Amur honeysuckle, and hazelnut.

Coniferous plants furnish winter cover, browse, and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, cutgrass, cordgrass, rushes, and sedges.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail, red fox, woodchuck, and mourning dove.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, muskrat, mink, and beaver.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, the shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock or a very firm dense layer, stone content, soil texture, and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and *small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, and the shrink-swell potential can cause the movement of footings. A high water table, depth to bedrock or large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. The depth to bedrock, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), the shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 12 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 12 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 12 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock, flooding, large stones, and content of organic matter.

Excessive seepage resulting from rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope and bedrock can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 12 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 13 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and the shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. These soils may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 13, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is as much as 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment (fig. 10). Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability in the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to help to control water erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock affect the construction of

Figure 10.—A pond reservoir in an area of Lamoni clay loam, 5 to 9 percent slopes, eroded.

terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

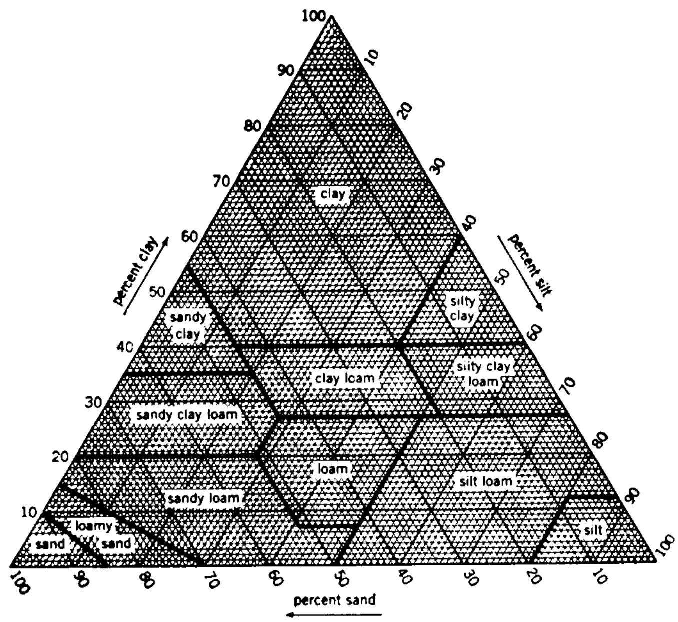


Figure 11.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Engineering Index Properties

Table 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 11). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(1)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated content of clay in each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at ⅓ bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

The shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous, loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 20 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 20 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 16, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 17, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 17 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 17 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 17. Only saturated zones within a depth of about 6 feet are indicated.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible.

Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion also is expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(14)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udoll (*Ud*, meaning humid, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Argiudolls (*Argi*, meaning argillic horizon, plus *udoll*, the suborder of the Mollisols that has a udic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Argiudolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed mesic Typic Argiudolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual (12)*. Many of the technical terms used in the descriptions are defined in *Soil Taxonomy (14)*. Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Armstrong Series

The Armstrong series consists of deep, somewhat poorly drained, slowly permeable soils on uplands.

These soils formed in a thin mantle of loess or loamy sediments and in the underlying paleosol, which formed in glacial till. Slopes range from 2 to 9 percent.

Typical pedon of Armstrong loam, 5 to 9 percent slopes, 1,950 feet west and 1,500 feet south of the northeast corner of sec. 21, T. 60 N., R. 22 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; many fine and very fine roots; medium acid; abrupt smooth boundary.

E—8 to 11 inches; dark brown (10YR 4/3) loam; mixed with some very dark grayish brown (10YR 3/2) material; weak fine granular structure; friable; many fine and very fine roots; medium acid; clear smooth boundary.

Bt1—11 to 16 inches; dark yellowish brown (10YR 4/4) clay loam; common fine prominent yellowish red (5YR 4/6) mottles; weak fine subangular blocky structure; firm; common fine and very fine roots; common distinct clay films; silt coatings on faces of peds; weak stone line at the base of the horizon; strongly acid; clear smooth boundary.

2Bt2—16 to 22 inches; dark brown (7.5YR 4/4) clay; common fine prominent red (2.5YR 4/6) and grayish brown (10YR 5/2) mottles; moderate fine angular blocky structure; firm; common fine and very fine roots; common distinct clay films; few fine pebbles; few fine black stains and concretions of iron and manganese oxide; strongly acid; gradual smooth boundary.

2Bt3—22 to 35 inches; yellowish brown (10YR 5/6) clay; common fine distinct brown (10YR 5/3) and few fine prominent red (2.5YR 4/6) mottles; weak fine subangular blocky structure; firm; few very fine roots; common distinct clay films; few fine pebbles; few fine black stains and concretions of iron and manganese oxide; slightly acid; gradual smooth boundary.

2Bt4—35 to 42 inches; strong brown (7.5YR 5/6) clay loam; common fine prominent light brownish gray (2.5Y 6/2) and common fine prominent yellowish brown (10YR 5/4) mottles; weak fine subangular blocky structure; firm; few very fine roots; few faint clay films; few fine and medium pebbles; common fine black stains and concretions of iron and manganese oxide; slightly acid; clear smooth boundary.

2C—42 to 60 inches; strong brown (7.5YR 5/6) clay loam; many medium prominent light brownish gray (2.5Y 6/2) mottles; massive; firm; few fine and medium pebbles; common black stains and concretions of iron and manganese oxide; neutral.

The depth to free carbonates ranges from 42 to more than 60 inches. In some pedons in cultivated or eroded areas, the E horizon has been incorporated in the Ap horizon and is evident only as silt coatings on peds.

The Ap horizon is loam or clay loam. The E horizon has value of 4 or 5 and chroma of 2 or 3. The Bt horizon has chroma of 3 to 6.

Colo Series

The Colo series consists of deep, poorly drained, moderately permeable soils on flood plains and in small drainageways. These soils formed in silty alluvium. Slopes range from 0 to 3 percent.

Typical pedon of Colo silty clay loam, 1,650 feet west and 775 feet south of the northeast corner of sec. 20, T. 63 N., R. 25 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; common fine and very fine roots; slightly acid; abrupt smooth boundary.

A1—8 to 14 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; common fine and very fine roots; medium acid; gradual smooth boundary.

A2—14 to 20 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; common fine and very fine roots; medium acid; gradual smooth boundary.

A3—20 to 30 inches; black (10YR 2/1) silty clay loam; weak medium subangular blocky structure; friable; common fine and very fine roots; slightly acid; diffuse smooth boundary.

BA—30 to 41 inches; very dark gray (10YR 3/1) silty clay loam; weak medium subangular blocky structure; firm; common fine and very fine roots; neutral; diffuse smooth boundary.

Bg—41 to 50 inches; very dark gray (10YR 3/1) silty clay loam; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium prismatic structure; firm; common fine and very fine roots; neutral; gradual smooth boundary.

BCg—50 to 60 inches; dark gray (10YR 4/1) silty clay loam; common fine prominent strong brown (7.5YR

4/6) mottles; weak medium prismatic structure; firm; few fine and very fine roots; neutral.

Some pedons have stratified overwash sediments, which are as much as 18 inches thick. The A horizon has value of 2 or 3 and chroma of 0 or 1. It dominantly is silty clay loam, but the range includes silt loam. The C horizon, if it occurs, has value of 3 to 5.

Edina Series

The Edina series consists of deep, poorly drained, very slowly permeable soils on uplands. These soils formed in loess. Slopes range from 0 to 2 percent.

Typical pedon of Edina silt loam, 350 feet south and 300 feet west of the center of sec. 10, T. 61 N., R. 25 W.

Ap—0 to 10 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; weak thin platy structure parting to weak fine granular; very friable; many fine roots; neutral; abrupt smooth boundary.

E—10 to 17 inches; dark grayish brown (10YR 4/2) silt loam, light gray (10YR 7/2) dry; moderate medium platy structure parting to weak fine granular; very friable; many fine roots; very dark gray (10YR 3/1) organic coatings on faces of peds; common fine black and yellowish brown stains and concretions of iron and manganese oxide; slightly acid; abrupt smooth boundary.

Btg1—17 to 31 inches; very dark gray (10YR 3/1) silty clay, very dark grayish brown (10YR 3/2) kneaded, gray (10YR 5/1) dry; few fine distinct yellowish brown (10YR 5/4) mottles; moderate fine and medium subangular blocky structure; very firm; common fine roots; many faint clay films; common fine black and yellowish brown stains and concretions of iron and manganese oxide; light gray (10YR 7/2) silt coatings on faces of some peds; slightly acid; gradual smooth boundary.

Btg2—31 to 42 inches; dark grayish brown (2.5Y 4/2) silty clay; common fine prominent yellowish brown (10YR 5/4) mottles; weak medium prismatic structure parting to weak medium subangular blocky; very firm; few fine roots; many distinct clay films; common fine black and yellowish brown stains and concretions of iron and manganese oxide; neutral; gradual smooth boundary.

Btg3—42 to 50 inches; grayish brown (2.5Y 5/2) silty clay; common fine prominent yellowish brown (10YR 5/6) mottles; weak fine and medium prismatic structure; firm; few fine roots; common or few faint clay films; common fine black and yellowish brown stains and concretions of iron and manganese oxide; neutral; gradual smooth boundary.

Cg—50 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; many fine and medium prominent yellowish brown (10YR 5/6) mottles; massive; firm; few fine roots; many fine and medium black and yellowish brown stains and concretions of iron and manganese oxide; neutral.

The Ap horizon has value of 2 or 3 and chroma of 1 or 2. The E horizon has value of 4 or 5 and chroma of 1 or 2.

Fatima Series

The Fatima series consists of deep, moderately well drained, moderately permeable soils on flood plains. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Fatima silt loam, 2,000 feet east and 1,700 feet north of the southwest corner of sec. 29, T. 62 N., R. 25 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak very fine granular structure; friable; common fine and medium roots; slightly acid; clear smooth boundary.

A—7 to 14 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak fine granular structure; friable; common fine and medium roots; neutral; clear smooth boundary.

Bw1—14 to 30 inches; dark grayish brown (10YR 4/2) silt loam; common fine faint dark brown (10YR 3/3) mottles; weak fine subangular blocky structure parting to weak fine granular; friable; common fine roots; few thin grayish brown (10YR 5/2) strata; slightly acid; gradual smooth boundary.

Bw2—30 to 55 inches; brown (10YR 4/3) silt loam; common fine faint dark grayish brown (10YR 4/2) mottles; weak fine subangular blocky structure; friable; common fine roots; few thin grayish brown (10YR 5/2) strata; slightly acid; gradual smooth boundary.

C—55 to 68 inches; dark grayish brown (10YR 4/2) silt loam; common fine distinct dark yellowish brown (10YR 4/4) mottles; appears massive but has thin bedding planes; friable; few very fine roots; weakly stratified; slightly acid.

The A horizon has value of 2 or 3 and chroma of 1 or

2. It dominantly is silt loam, but loam and silty clay loam are within the range. The Bw horizon has value of 4 or 5.

Gara Series

The Gara series consists of deep, moderately well drained, moderately slowly permeable soils on uplands. These soils formed in glacial till. Slopes range from 9 to 20 percent.

Typical pedon of Gara loam, 9 to 14 percent slopes, 2,400 feet east and 1,200 feet south of the northwest corner of sec. 7, T. 62 N., R. 25 W.

A—0 to 7 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak very fine granular structure; friable; many fine and medium roots; few fine pebbles; medium acid; clear smooth boundary.

E—7 to 10 inches; brown (10YR 5/3) loam; weak very fine granular structure; friable; many fine and medium roots; few fine pebbles; medium acid; clear smooth boundary.

Bt1—10 to 15 inches; dark brown (10YR 4/3) clay loam; moderate fine subangular blocky structure; firm; many fine and medium roots; few faint clay films; grayish brown (10YR 5/2) silt coatings on faces of peds; common pebbles and stones; very strongly acid; clear smooth boundary.

Bt2—15 to 24 inches; dark yellowish brown (10YR 4/4) clay loam; moderate medium subangular blocky structure; firm; common fine and very fine roots; common distinct clay films; common pebbles and stones; very strongly acid; gradual smooth boundary.

Bt3—24 to 36 inches; dark yellowish brown (10YR 4/6) clay loam; few fine prominent grayish brown (2.5Y 5/2) mottles; weak fine and medium subangular blocky structure; firm; few fine and medium roots; common faint clay films; common pebbles and stones; common fine black stains and concretions of iron and manganese oxide; very strongly acid; clear smooth boundary.

C1—36 to 45 inches; yellowish brown (10YR 5/6) clay loam; common fine prominent grayish brown (2.5Y 5/2) mottles; weak medium prismatic structure; firm; few fine and very fine roots; common pebbles and stones; few fine black stains and concretions of iron and manganese oxide; common very dark gray coatings along root channels, in cracks, and on faces of some peds; common soft accumulations and concretions of carbonate; slight effervescence; neutral; clear smooth boundary.

C2—45 to 60 inches; yellowish brown (10YR 5/6) clay loam; many fine and medium prominent grayish brown (2.5Y 5/2) mottles; appears massive but has some vertical cleavage; firm; few fine and very fine roots; common pebbles and stones; few very dark gray coatings along root channels and in cracks; common soft accumulations of carbonate; strong effervescence; mildly alkaline.

The A horizon has chroma of 1 or 2. It is loam or clay loam. The Bt horizon has value of 4 or 5.

Grundy Series

The Grundy series consists of deep, somewhat poorly drained, slowly permeable soils on uplands and high stream terraces. These soils formed in noncalcareous loess. Slopes range from 2 to 5 percent.

Typical pedon of Grundy silt loam, 2 to 5 percent slopes, 1,300 feet north and 140 feet west of the southeast corner of sec. 11, T. 61 N., R. 24 W.

Ap—0 to 6 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; common fine and very fine roots; slightly acid; clear smooth boundary.

A—6 to 11 inches; mixed black (10YR 2/1) and very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; common fine and very fine roots; medium acid; clear smooth boundary.

Bt1—11 to 16 inches; dark grayish brown (10YR 4/2) silty clay loam; very dark gray (10YR 3/1) on faces of some peds; few fine distinct yellowish brown (10YR 5/4) mottles; moderate fine subangular blocky structure; firm; common fine and very fine roots; few faint clay films; medium acid; clear smooth boundary.

Bt2—16 to 21 inches; dark grayish brown (10YR 4/2) silty clay; common fine prominent yellowish brown (10YR 5/6) and common fine distinct yellowish brown (10YR 5/4) mottles; moderate fine subangular blocky structure; firm; few very fine roots; common distinct clay films; strongly acid; gradual smooth boundary.

Bt3—21 to 32 inches; dark grayish brown (10YR 4/2) silty clay; common fine distinct yellowish brown (10YR 5/4) and common fine prominent yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; firm; few very fine roots; common distinct clay films; common fine concretions of iron and manganese oxide; slightly acid; gradual smooth boundary.

Btg—32 to 49 inches; grayish brown (10YR 5/2) silty clay loam; common fine prominent yellowish brown (10YR 5/6) and common fine distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; firm; few very fine roots; common distinct clay films; common fine black stains and concretions of iron and manganese oxide; neutral; gradual smooth boundary.

Cg—49 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine prominent yellowish brown (10YR 5/8) and dark yellowish brown (10YR 4/6) mottles; massive; firm; few very fine roots; common fine tubular pores with dark coatings; common fine black stains and concretions of iron and manganese oxide; neutral.

The thickness of the mollic epipedon ranges from 10 to 14 inches. The A horizon has value of 2 or 3. It is silt loam or silty clay loam. The upper 20 inches of the argillic horizon ranges from 42 to 48 percent clay.

Grundy silty clay loam, 2 to 5 percent slopes, eroded, has a dark surface layer that is slightly thinner than is definitive for the series. This difference, however, does not significantly affect the use and management of the soil.

Haig Series

The Haig series consists of deep, poorly drained, very slowly permeable soils on high stream terraces. These soils formed in loess. Slopes range from 0 to 2 percent.

Typical pedon of Haig silt loam, 2,550 feet south and 850 feet east of the northwest corner of sec. 34, T. 63 N., R. 25 W.

Ap—0 to 9 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; common fine and very fine roots; slightly acid; clear smooth boundary.

A—9 to 13 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; common fine and very fine roots; strongly acid; clear smooth boundary.

BA—13 to 18 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; firm; common fine and very fine roots; few distinct clay films; few fine black stains and concretions of iron and manganese oxide; strongly acid; clear smooth boundary.

Bt—18 to 24 inches; very dark gray (10YR 3/1) silty clay; common fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; firm; common fine and very fine roots; few distinct clay films; few fine black stains and concretions of iron and manganese oxide; strongly acid; gradual smooth boundary.

Btg1—24 to 34 inches; dark gray (10YR 4/1) silty clay; common fine distinct brown (10YR 4/3) mottles; weak medium prismatic structure parting to weak fine subangular blocky; firm; common fine and very fine roots; common distinct clay films; few fine black and yellowish brown stains and concretions of iron and manganese oxide; medium acid; gradual smooth boundary.

Btg2—34 to 48 inches; grayish brown (2.5Y 5/2) silty clay; common fine distinct dark gray (10YR 4/1) and common fine prominent dark yellowish brown (10YR 4/4) mottles; weak medium prismatic structure parting to weak medium subangular blocky; firm; common fine and very fine roots; common distinct clay films; few fine black and yellowish brown stains and concretions of iron and manganese oxide; medium acid; gradual smooth boundary.

Btg3—48 to 60 inches; olive gray (5Y 5/2) silty clay loam; few fine prominent dark yellowish brown (10YR 4/4) mottles; weak medium prismatic structure; firm; few fine and very fine roots; few distinct clay films; few fine black and yellowish brown stains and concretions of iron and manganese oxide; slightly acid.

The mollic epipedon is 20 to 28 inches thick. Mollic colors generally extend into the Bt horizon.

Humeston Series

The Humeston series consists of deep, poorly drained, very slowly permeable soils on flood plains. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Humeston silt loam, 900 feet north and 1,600 feet west of the southeast corner of sec. 29, T. 61 N., R. 24 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; common fine and very fine roots; neutral; clear smooth boundary.

A—7 to 13 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable;

common fine and very fine roots; slightly acid; clear smooth boundary.

E—13 to 20 inches; dark gray (10YR 4/1) silt loam; common fine distinct dark brown (7.5YR 3/2) mottles; weak fine subangular blocky structure parting to weak thin platy; friable; common fine and very fine roots; light gray (10YR 7/1) silt coatings on faces of peds; medium acid; clear smooth boundary.

Bt1—20 to 26 inches; very dark gray (10YR 3/1) silty clay loam; weak fine subangular blocky structure; firm; common fine and very fine roots; light gray (10YR 7/1) silt coatings on faces of peds; common distinct clay films; common fine black and yellowish brown stains and concretions of iron and manganese oxide; very strongly acid; gradual smooth boundary.

Bt2—26 to 38 inches; black (10YR 2/1) silty clay; moderate fine and medium subangular blocky structure; firm; common fine and very fine roots; light gray (10YR 7/1) silt coatings on faces of peds; common distinct clay films; common fine black and yellowish brown stains and concretions of iron and manganese oxide; strongly acid; gradual smooth boundary.

Bt3—38 to 50 inches; black (10YR 2/1) silty clay; weak fine subangular blocky structure; firm; few fine and very fine roots; common distinct clay films; common fine black and yellowish brown stains and concretions of iron and manganese oxide; medium acid; gradual smooth boundary.

Bt4—50 to 60 inches; very dark gray (10YR 3/1) silty clay loam; common fine distinct yellowish brown (10YR 5/4) mottles; moderate fine subangular blocky structure; firm; few distinct clay films; common fine black and yellowish brown stains and concretions of iron and manganese oxide; slightly acid.

The combined thickness of the A and E horizons ranges from 16 to 25 inches. The A horizon is silt loam or silty clay loam. The E horizon has value of 4 or 5. The Bt horizon has value of 2 to 4.

Kilwinning Series

The Kilwinning series consists of deep, poorly drained, very slowly permeable soils on uplands. These soils formed in loess. Slopes range from 2 to 5 percent.

Typical pedon of Kilwinning silt loam, 2 to 5 percent slopes, 1,375 feet east and 1,050 feet south of the northwest corner of sec. 9, T. 60 N., R. 22 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; friable; few fine and very fine roots; slightly acid; abrupt smooth boundary.

Btg1—8 to 13 inches; dark grayish brown (10YR 4/2) silty clay loam; common fine prominent strong brown (7.5YR 4/6) mottles; moderate fine subangular blocky structure; firm; few fine and very fine roots; few faint clay films; gray (10YR 6/1) silt coatings on faces of peds; medium acid; clear smooth boundary.

Btg2—13 to 21 inches; dark grayish brown (10YR 4/2) silty clay; common fine prominent strong brown (7.5YR 4/6) mottles; weak fine subangular blocky structure; firm; few fine and very fine roots; common distinct clay films; few fine black stains and concretions of iron and manganese oxide; medium acid; gradual smooth boundary.

Btg3—21 to 26 inches; grayish brown (2.5Y 5/2) silty clay; common fine prominent yellowish brown (10YR 5/6) and few fine prominent strong brown (7.5YR 4/6) mottles; weak fine subangular blocky structure; firm; few fine and very fine roots; common distinct clay films; few fine black stains and concretions of iron and manganese oxide; medium acid; gradual smooth boundary.

Btg4—26 to 43 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine prominent dark yellowish brown (10YR 4/4) and common fine prominent strong brown (7.5YR 4/6) mottles; weak fine and medium subangular blocky structure; firm; few fine and very fine roots; common distinct clay films; few fine black stains and concretions of iron and manganese oxide; slightly acid; gradual smooth boundary.

Btg5—43 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; weak medium subangular blocky structure; firm; few faint clay films; common fine prominent dark yellowish brown stains and concretions of iron and manganese oxide; neutral.

The A horizon dominantly is silt loam, but the range includes silty clay loam. The Bt horizon has shiny pressure faces on many of the peds. The upper part of the Btg horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 1 or 2. The lower part has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 or 2. The C horizon, if it occurs, has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 4 to 8.

Lamoni Series

The Lamoni series consists of deep, somewhat poorly drained, slowly permeable soils on uplands. These soils formed in a thin mantle of loess and in the underlying paleosol, which formed in glacial till. Slopes range from 5 to 9 percent.

Typical pedon of Lamoni loam, 5 to 9 percent slopes, 2,370 feet west and 295 feet south of the northeast corner of sec. 12, T. 61 N., R. 24 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak fine subangular blocky structure; friable; many fine and very fine roots; medium acid; abrupt smooth boundary.

AB—8 to 11 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; moderate fine subangular blocky structure; friable; many fine and very fine roots; strongly acid; clear smooth boundary.

2Bt1—11 to 17 inches; dark grayish brown (10YR 4/2) clay; very dark gray (10YR 3/1) on faces of some peds; common fine prominent yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; many fine and very fine roots; few faint clay films; few fine pebbles; strongly acid; clear smooth boundary.

2Bt2—17 to 30 inches; grayish brown (2.5Y 5/2) clay; many medium prominent yellowish brown (10YR 5/6) and few fine prominent strong brown (7.5YR 4/6) mottles; weak medium subangular blocky structure; very firm; common fine and very fine roots; common distinct clay films; few fine pebbles; common fine black stains and concretions of iron and manganese oxide; medium acid; gradual smooth boundary.

2Bt3—30 to 45 inches; grayish brown (2.5Y 5/2) clay; common medium prominent dark yellowish brown (10YR 4/6) and common fine prominent yellowish brown (10YR 5/4) mottles; weak medium prismatic structure; very firm; few very fine roots; common distinct clay films; few fine pebbles; common fine black stains and concretions of iron and manganese oxide; medium acid; gradual smooth boundary.

2Bt4—45 to 60 inches; gray (5Y 5/1) clay; common fine prominent dark yellowish brown (10YR 4/6) and yellowish brown (10YR 5/4) mottles; weak medium prismatic structure; firm; few very fine roots; few faint clay films; few fine pebbles; common fine black stains and concretions of iron and manganese oxide; slightly acid.

The mollic epipedon is 10 to 13 inches thick. The Ap horizon has value of 2 or 3. It is loam or clay loam. The Bt horizon has value of 4 to 6 and chroma of 1 to 6. It is clay or clay loam. The C horizon, if it occurs, is highly mottled with hue of 10YR to 5Y, value of 4 to 6, and chroma of 1 to 8.

Lamoni clay loam, 5 to 9 percent slopes, eroded, has a dark surface layer that is slightly thinner than is definitive for the series. This difference, however, does not significantly affect the use and management of the soil.

Landes Series

The Landes series consists of deep, well drained soils on flood plains. These soils formed in stratified, loamy and sandy alluvium. Permeability is moderately rapid in the upper part of the profile and rapid in the lower part. Slopes range from 0 to 3 percent.

Typical pedon of Landes fine sandy loam, 0 to 3 percent slopes, 1,400 feet south and 2,600 feet east of the northwest corner of sec. 15, T. 62 N., R. 25 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; neutral; clear smooth boundary.

A—7 to 13 inches; dark brown (10YR 3/3) fine sandy loam, brown (10YR 5/3) dry; weak fine subangular blocky structure parting to weak fine granular; friable; slightly acid; clear smooth boundary.

Bw1—13 to 21 inches; brown (10YR 4/3) fine sandy loam; weak fine subangular blocky structure parting to weak fine granular; very friable; slightly acid; clear smooth boundary.

Bw2—21 to 32 inches; dark yellowish brown (10YR 4/4) loamy fine sand; weak fine subangular blocky structure parting to weak fine granular; very friable; slightly acid; gradual smooth boundary.

C1—32 to 47 inches; yellowish brown (10YR 5/4) fine sand; single grain; loose; neutral; gradual smooth boundary.

C2—47 to 60 inches; stratified yellowish brown (10YR 5/4) and pale brown (10YR 6/3) fine sand; single grain; loose; neutral.

The A horizon has value of 2 or 3. It is fine sandy loam or loam. The B horizon has value of 3 to 6 and chroma of 2 to 4. In some pedons it has mottles in the lower part. The C horizon has hue of 5YR to 2.5Y, value of 4 to 6, and chroma of 3 or 4. It is dominantly loamy fine sand, loamy sand, fine sand, or sandy loam. In some pedons, however, it has strata of loam or silt loam.

Nodaway Series

The Nodaway series consists of deep, moderately well drained, moderately permeable soils on flood plains. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Nodaway silt loam, 75 feet south and 1,200 feet east of the northwest corner of sec. 36, T. 61 N., R. 24 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak fine granular structure; friable; common fine and very fine roots; neutral; clear smooth boundary.

C—9 to 60 inches; stratified brown (10YR 4/3), grayish brown (10YR 5/2), dark grayish brown (10YR 4/2), and very dark grayish brown (10YR 3/2) silt loam; massive tending to be platy because of stratification; friable; common fine black and yellowish brown stains and concretions of iron and manganese oxide; common fine and very fine roots; many wormholes and root channels; neutral.

The Ap horizon has chroma of 1 or 2. The sequence and thickness of the strata in the C horizon vary. Some thin lenses of material coarser than silt loam are within a depth of 40 inches. Dark, medium textured and fine textured buried soils are below a depth of 36 inches in some pedons.

Pershing Series

The Pershing series consists of deep, somewhat poorly drained, slowly permeable soils on uplands. These soils formed in silty, noncalcareous loess. Slopes range from 2 to 5 percent.

Typical pedon of Pershing silt loam, 2 to 5 percent slopes, 600 feet north and 200 feet east of the southwest corner of sec. 28, T. 60 N., R. 22 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak fine granular structure; friable; many fine and very fine roots; strongly acid; abrupt smooth boundary.

E—7 to 13 inches; dark grayish brown (10YR 4/2) silt loam; few fine prominent yellowish brown (10YR 5/6) mottles; weak thin platy structure; friable; common fine and very fine roots; strongly acid; clear smooth boundary.

Bt1—13 to 19 inches; dark grayish brown (10YR 4/2) silty clay loam; common fine prominent yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; firm; common fine and very fine roots; few faint clay films; gray (10YR 5/1) silt coatings on faces of peds; strongly acid; clear smooth boundary.

Bt2—19 to 25 inches; brown (10YR 4/3) silty clay; common fine distinct yellowish brown (10YR 5/6) and common fine faint dark grayish brown (10YR 4/2) mottles; weak fine subangular blocky structure; very firm; common fine and very fine roots; common distinct clay films; few fine black and strong brown stains and concretions of iron and manganese oxide; strongly acid; gradual smooth boundary.

Bt3—25 to 31 inches; mottled brown (10YR 5/3), grayish brown (2.5Y 5/2), and yellowish brown (10YR 5/8) silty clay; weak fine subangular blocky structure; very firm; few fine and very fine roots; common distinct clay films; few fine black and strong brown stains and concretions of iron and manganese oxide; medium acid; gradual smooth boundary.

Bt4—31 to 42 inches; grayish brown (2.5Y 5/2) silty clay; many fine prominent yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; very firm; few fine and very fine roots; common faint clay films; common fine black and strong brown stains and concretions of iron and manganese oxide; medium acid; gradual smooth boundary.

Bt5—42 to 55 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine prominent yellowish brown (10YR 5/6) mottles; weak fine prismatic structure; firm; common faint clay films; few dark gray clay flows in old root channels; weak fine black and strong brown stains and concretions of iron and manganese oxide; slightly acid; clear smooth boundary.

BC—55 to 60 inches; gray (10YR 5/1) silty clay loam; many medium distinct dark yellowish brown (10YR 4/4) and common fine prominent yellowish brown (10YR 5/6) mottles; weak medium and coarse prismatic structure; firm; few dark gray clay flows in old root channels; few fine black stains and concretions of iron and manganese oxide; slightly acid.

The dark surface layer is 6 to 8 inches thick. The Ap horizon is silt loam or silty clay loam. It has chroma of 1 or 2. In pedons where the soils are eroded or cultivated, all of the E horizon is mixed with the A horizon. The Bt horizon has chroma of 2 to 8. Some pedons have a paleosol in the lower part of the solum.

Shelby Series

The Shelby series consists of deep, moderately well drained, moderately slowly permeable soils on uplands. These soils formed in glacial till. Slopes range from 9 to 20 percent.

Typical pedon of Shelby loam, 9 to 14 percent slopes, 1,100 feet north and 660 feet west of the southeast corner of sec. 36, T. 62 N., R. 24 W.

A1—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; many fine and very fine roots; medium acid; clear smooth boundary.

A2—7 to 12 inches; very dark brown (10YR 2/2) clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; common fine and very fine roots; medium acid; clear smooth boundary.

BA—12 to 18 inches; dark brown (10YR 3/3) clay loam; a few brown (10YR 4/3) peds; very dark gray (10YR 3/1) on faces of most peds; moderate fine subangular blocky structure; firm; common fine and very fine roots; few faint clay films; few fine pebbles; medium acid; clear smooth boundary.

Bt1—18 to 25 inches; brown (10YR 4/3) clay loam; very dark grayish brown (10YR 3/2) on faces of some peds; moderate fine subangular blocky structure; firm; few fine and very fine roots; common distinct clay films; few fine pebbles; few fine and very fine roots; strongly acid; clear smooth boundary.

Bt2—25 to 37 inches; yellowish brown (10YR 5/4) clay loam; few fine prominent grayish brown (2.5Y 5/2) and few fine prominent strong brown (7.5YR 4/6) mottles; weak fine subangular blocky structure; firm; few fine and very fine roots; few distinct clay films; few fine and medium pebbles; strongly acid; clear smooth boundary.

C1—37 to 48 inches; yellowish brown (10YR 5/6) clay loam; common fine prominent grayish brown (2.5Y 5/2) and strong brown (7.5YR 4/6) mottles; appears massive but has some vertical cleavage; firm; few very fine roots; few fine and medium pebbles; few black stains; common fine and medium soft masses and concretions of calcium; strong effervescence; mildly alkaline; gradual smooth boundary.

C2—48 to 60 inches; yellowish brown (10YR 5/6) clay loam; common medium prominent grayish brown (2.5Y 5/2) mottles; appears massive but has some vertical cleavage; firm; few very fine roots; few black stains; common fine and medium soft masses and concretions of calcium; few fine and medium pebbles; strong effervescence; mildly alkaline.

The depth to free carbonates ranges from 30 to 49 inches. The thickness of the mollic epipedon ranges from 10 to 18 inches.

The A1 or Ap horizon has value of 2 or 3. It is loam or clay loam. The C horizon is highly mottled with hue of 7.5YR to 5Y, value of 4 to 6, and chroma of 2 to 6.

Shelby clay loam, 9 to 14 percent slopes, eroded, and Shelby clay loam, 14 to 20 percent slopes, eroded, have a dark surface layer that is slightly thinner than is definitive for the series. This difference, however, does not significantly affect the use and management of the soils.

Vanmeter Series

The Vanmeter series consists of moderately deep, moderately well drained, very slowly permeable soils on uplands. These soils formed in material weathered from shale. Slopes range from 9 to 40 percent.

Typical pedon of Vanmeter flaggy silty clay loam, 9 to 40 percent slopes, 1,700 feet south and 975 feet west of the northeast corner of sec. 14, T. 61 N., R. 25 W.

A—0 to 6 inches; dark grayish brown (10YR 4/2) flaggy silty clay loam, light brownish gray (10YR 6/2) dry; weak fine and medium subangular blocky structure; friable; many roots most of which are very fine but range to few coarse in size; about 15 percent limestone fragments; strong effervescence; mildly alkaline; clear smooth boundary.

Bw1—6 to 9 inches; dark grayish brown (2.5Y 4/2) and light olive brown (2.5Y 5/4) silty clay; moderate medium subangular blocky structure; firm; common roots most of which are very fine but range to few coarse in size; strong effervescence; mildly alkaline; clear smooth boundary.

Bw2—9 to 20 inches; grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/4) silty clay; weak medium subangular blocky structure; firm; few very fine to medium roots; strong effervescence; mildly alkaline; clear smooth boundary.

BC—20 to 32 inches; light olive brown (2.5Y 5/4), grayish brown (2.5Y 5/2), yellowish brown (10YR 5/6), and strong brown (7.5YR 4/6) silty clay; weak thin platy structure parting to weak fine subangular blocky; firm; few very fine to medium roots; about 10 percent shale fragments; strong effervescence; mildly alkaline; abrupt smooth boundary.

Cr—32 to 60 inches; grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6) weathered bedrock.

The content of shale and limestone fragments ranges, by volume, from 0 to 15 percent throughout the solum. The A horizon typically is flaggy silty clay loam, but in some pedons it is flaggy silt loam and in others is not flaggy. It typically is dark grayish brown (10YR 4/2) but ranges from very dark gray (10YR 3/1) to grayish brown (10YR 5/2). It is less than 4 inches thick in areas where it is very dark gray. The Bw horizon has hue of 2.5Y to 7.5YR, value of 4 to 6, and chroma of 2 to 6. It is silty clay or clay. The Cr horizon has hue of 5Y to 7.5YR, value of 2 to 8, and chroma of 1 to 6.

Vesser Series

The Vesser series consists of deep, somewhat poorly drained, moderately permeable soils on flood plains. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Vesser silt loam, 1,650 feet south and 1,800 feet west of the northeast corner of sec. 20, T. 63 N., R. 25 W.

Ap—0 to 10 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; many fine and very fine roots; medium acid; clear smooth boundary.

A—10 to 15 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; common fine and very fine roots; medium acid; clear smooth boundary.

E1—15 to 20 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; few fine faint gray (10YR 5/1) and dark brown (10YR 4/3) mottles; weak medium platy structure parting to weak fine subangular blocky; friable; common fine and very fine roots; light gray (10YR 7/1) silt coatings on faces of peds; medium acid; clear smooth boundary.

E2—20 to 28 inches; dark grayish brown (10YR 4/2) silt loam; common fine distinct dark yellowish brown (10YR 4/4) and few fine faint gray (10YR 5/1) mottles; weak medium platy structure parting to weak fine subangular blocky; friable; common fine and very fine roots; light gray (10YR 7/1) silt coatings on faces of peds; strongly acid; clear smooth boundary.

Btg1—28 to 35 inches; dark grayish brown (10YR 4/2) silty clay loam; common fine distinct dark yellowish brown (10YR 4/4) and common medium faint gray (10YR 5/1) mottles; weak medium subangular blocky structure; firm; common fine and very fine roots; common distinct clay films; light gray (10YR 7/1) silt coatings on faces of peds; few fine black stains and concretions of iron and manganese oxide; strongly acid; clear smooth boundary.

Btg2—35 to 45 inches; dark grayish brown (10YR 4/2) silty clay loam; many fine distinct dark yellowish brown (10YR 4/4) and common fine prominent yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak medium subangular blocky; firm; few fine and very fine roots; common distinct clay films; light gray (10YR 7/1) silt coatings on faces of peds; common fine black stains and concretions of iron and manganese oxide; common black (10YR 2/1) coatings along root channels and in cracks; strongly acid; gradual smooth boundary.

BCg—45 to 60 inches; dark grayish brown (10YR 4/2) silty clay loam; many fine and medium prominent dark yellowish brown (10YR 4/6) mottles; weak medium prismatic structure; firm; few fine and very fine roots; few fine black stains of iron and manganese oxide; common black (10YR 2/1) coatings along root channels; strongly acid.

The A and E horizons have chroma of 1 or 2. The E horizon has value of 3 to 5. The Btg horizon has value of 4 or 5 and chroma of 1 or 2.

Vigar Series

The Vigar series consists of deep, moderately well drained, moderately slowly permeable soils on foot slopes. These soils formed in loamy local alluvium derived from glacial till. Slopes range from 2 to 5 percent.

Typical pedon of Vigar loam, 2 to 5 percent slopes, 2,300 feet east and 300 feet north of the southwest corner of sec. 36, T. 62 N., R. 25 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak very fine granular structure; friable; common fine and very fine roots; slightly acid; gradual smooth boundary.

A1—9 to 20 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; common fine and very fine roots; slightly acid; gradual smooth boundary.

A2—20 to 30 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; common fine and very fine roots; slightly acid; gradual smooth boundary.

BA—30 to 39 inches; very dark grayish brown (10YR 3/2) clay loam; common fine distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; firm; common fine and very fine roots; very dark gray (10YR 3/1) coatings on faces of most peds and along root channels and in cracks; slightly acid; gradual smooth boundary.

Bt1—39 to 48 inches; dark brown (10YR 4/3) clay loam; few fine faint dark yellowish brown (10YR 4/4) and dark grayish brown (10YR 4/2) mottles; moderate fine subangular blocky structure; firm; few fine and very fine roots; common distinct clay films; common distinct black clay flows in root channels and yellowish brown stains and concretions of iron and manganese oxide; slightly acid; gradual smooth boundary.

Bt2—48 to 56 inches; dark yellowish brown (10YR 4/4) clay loam; few fine distinct dark grayish brown (10YR 4/2) mottles; moderate fine subangular blocky structure; firm; few fine and very fine roots; common distinct clay films; common distinct black clay flows in root channels and yellowish brown stains and concretions of iron and manganese oxide; slightly acid; gradual smooth boundary.

Bt3—56 to 74 inches; dark yellowish brown (10YR 4/4) clay loam; common fine distinct dark grayish brown (10YR 4/2) mottles; moderate fine subangular blocky structure; firm; few fine and very fine roots; common distinct clay films; few distinct black clay flows in root channels and yellowish brown stains; slightly acid.

The thickness of the mollic epipedon ranges from 24 to 40 inches. The Ap and A horizon have value of 2 or 3 and chroma of 1 or 2. They commonly are loam, but silt loam and silty clay loam are within the range. The Bt horizon has value of 4 or 5 and chroma of 2 to 4.

Wabash Series

The Wabash series consists of deep, very poorly drained, very slowly permeable soils on wide flood plains. These soils formed in clayey alluvium. Slopes are 0 to 1 percent.

Typical pedon of Wabash silty clay, 600 feet south and 2,000 feet east of the northwest corner of sec. 15, T. 62 N., R. 25 W.

Ap—0 to 6 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; firm; common fine and very fine roots; slightly acid; abrupt smooth boundary.

A1—6 to 10 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; firm; few fine and very fine roots; slightly acid; clear smooth boundary.

A2—10 to 18 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; firm; few fine and very fine roots; few fine yellowish brown stains and concretions of iron and manganese oxide; medium acid; clear smooth boundary.

Bg1—18 to 30 inches; black (10YR 2/1) silty clay; common fine distinct brown (10YR 4/3) mottles; moderate fine and medium subangular blocky structure; very firm; few fine and very fine roots; few fine and medium yellowish brown stains and concretions of iron and manganese oxide; slightly acid; gradual smooth boundary.

Bg2—30 to 42 inches; very dark gray (10YR 3/1) silty clay; common fine prominent yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; very firm; few very fine roots; common fine and medium black and yellowish brown stains and concretions of iron and manganese oxide; slightly acid; gradual smooth boundary.

Bg3—42 to 55 inches; dark gray (10YR 4/1) silty clay; common fine prominent yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; very firm; common very dark gray coatings on faces of peds; common fine black and yellowish brown stains and concretions of iron and manganese oxide; slightly acid; gradual smooth boundary.

Cg—55 to 60 inches; gray (10YR 5/1) silty clay; many medium prominent strong brown (7.5YR 5/6) mottles; massive; firm; common very dark gray coatings on faces of peds; few fine yellowish brown stains and concretions of iron and manganese oxide; slightly acid.

The Ap and A horizons have value of 2 or 3 and chroma of 2 or less. The part of the Bg horizon within a depth of 36 inches has the same range of color as the A horizon. Below a depth of 36 inches, the matrix commonly has value of 4 or 5.

Zook Series

The Zook series consists of deep, poorly drained, slowly permeable soils on flood plains. These soils formed in clayey alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Zook silty clay loam, 700 feet north and 200 feet east of the southwest corner of sec. 32, T. 63 N., R. 25 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; common fine and very fine roots; slightly acid; clear smooth boundary.

A1—8 to 15 inches; black (N 2/0) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; common fine and very fine roots; medium acid; clear smooth boundary.

A2—15 to 28 inches; black (N 2/0) silty clay, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; firm; common fine and very fine roots; medium acid; gradual smooth boundary.

A3—28 to 35 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; firm; common fine and very fine roots; many distinct black (N 2/0) organic coatings on faces of peds; medium acid; diffuse smooth boundary.

Bg—35 to 55 inches; very dark gray (10YR 3/1) silty clay; common fine distinct dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; firm; common fine and very fine roots; few faint black (10YR 2/1) organic coatings on faces of peds; few fine black and yellowish brown concretions of iron and manganese oxide; slightly acid; diffuse smooth boundary.

Cg—55 to 60 inches; dark gray (10YR 4/1) silty clay; common fine distinct dark yellowish brown (10YR 4/4) mottles; appears massive but has some vertical cleavage; firm; few fine and very fine roots; few fine black and yellowish brown concretions of iron and manganese oxide; neutral.

The thickness of the mollic epipedon ranges from 40 to 60 inches. The A horizon ranges from 30 to 40 inches in thickness. It has value of 2 or 3. It is dominantly silty clay loam in the upper part, but the range includes silty clay.

Factors of Soil Formation

Soil forms through processes that act on accumulated or deposited geologic material. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material; the climate under which the soil material accumulated and has existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time that the forces of soil formation have acted on the soil material.

Climate and plant and animal life are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for the transformation of the parent material into a soil that has distinct horizons. Some time is always required for the differentiation of soil horizons. Generally, a long time is required for the development of distinct horizons.

Plants and Animals

Plants, burrowing animals, insects, bacteria, and fungi are important in the formation of soils. They affect the organic matter, plant nutrients, structure, and porosity of the soils.

Many of the soils in Grundy County formed when the vegetation was mainly tall prairie grasses. These soils, generally known as prairie soils, have a thick, dark surface layer that has a high content of organic matter because of abundant bacteria and decayed fine grass roots. Soils that formed under this kind of plant cover include the Edina, Grundy, Haig, Lamoni, and Shelby soils.

Several of the soils have been influenced by grass and trees. They have properties intermediate between those of the soils that formed under grass and those of the soils that formed under trees. Examples of these soils, generally known as transitional soils, are the Armstrong, Gara, and Pershing soils.

Worms, insects, burrowing animals, and humans disturb and otherwise affect the soil. Bacteria and fungi, however, have more important effects on soil formation than the animals. They cause the rotting of organic material, improve tilth, and fix nitrogen in the soils. The population of soil organisms is directly related to the rate of decomposition of organic material in the soil. The kinds of organisms in a given area and their activity are determined by differences in the vegetation.

Human activities have had a tremendous effect on the soils in this county. Because of intensive cultivation and overgrazing, erosion has been severe in many small areas. As much as 15 inches of topsoil has been lost. In many areas the soils are still eroding at an excessive rate.

Climate

Climate has been an important factor in the formation of the soils in Grundy County. In the past 1 million years, variations in the climate have significantly affected the soils.

The subhumid midcontinental climate of the county has changed little in the past 6,500 years. This period has been drier than previous ones and has favored native prairie grasses.

The period between 6,500 and 20,000 years ago was cool and moist. The climate favored the growth of forest vegetation. Since that period, the extent of the forest vegetation has diminished in all areas except for some areas near streams. Some soils in the county have a moderately thick, dark surface layer, which indicates that they formed under transitional prairie-timber vegetation.

Changes in climate caused the glacial periods. Thousands of years of cool temperatures resulted in the massive glaciers of the Nebraska and Kansas ages. Warmer temperatures later resulted in severe geologic erosion and the deposition of loess, which once covered most of the county. Extreme changes in climate occurred very slowly; therefore, there were long intermediate periods when different types of vegetation grew. Soils formed on the surface and were later covered by loess, truncated, and mixed by erosion or completely washed away. Some soils formed mostly in these old truncated or weathered areas. Examples are the Armstrong and Lamoni soils.

The prevailing winds are from the southwest. Most of the loess, therefore, was blown in a northeasterly direction, probably from the bottom land along the Missouri River and other large streams. The distance that the loess was carried by the wind depended on the size of the particles. Because most of the loess that covered Grundy County was fine silt and clay, the soils that formed in loess have a clayey subsoil. Grundy, Edina, Haig, Kilwinning, and Pershing soils are examples.

Local conditions can modify the influence of the general climate in a region. For example, south-facing slopes are warmer and drier than north-facing slopes, and poorly drained soils on bottom land are wetter and cooler and stay wet and cool longer than the soils in the higher adjacent areas. These local differences account for some of the differences among the soils in the county.

Parent Material

Parent material is the unconsolidated mass in which a soil forms. It determines the limits of the chemical and mineral composition of the soil. In Grundy County, the soils formed in loess, glacial till, alluvium, or residual material or in a combination of these.

Loess is wind-deposited silty material. It probably was blown from the larger flood plains. It remains on most of the wider ridges in the county and is 10 feet thick in some areas. Grundy and Pershing soils formed in loess.

Prior to the deposition of loess, thick layers of glacial till were deposited over the bedrock. The till generally is yellowish brown and is a heterogeneous mass of soil material. The glacial till ranges from a few feet to more than 300 feet in thickness. In some areas a soil formed in the glacial till before the loess was deposited. In many of these areas, the glacial material is now exposed. The areas generally are narrow. Armstrong and Lamoni soils formed in these areas. Their surface layer, which formed after the loess was deposited, varies in thickness. In steeper areas the unweathered glacial material was exposed by geologic erosion at a later time. Gara and Shelby soils formed in this material.

Alluvium is material that was transported by water and deposited on the nearly level flood plains along streams. Most of this material was removed from the surrounding uplands. The material ranges from clay and silt to fine sand. Wabash and Zook soils formed in clayey alluvial material, and Colo, Fatima, Humeston, Nodaway, and Vesser soils formed in the more silty alluvial material. Landes soils formed in stratified, loamy and sandy alluvium. Vigar soils formed in loamy alluvium.

The residuum in Grundy County is material that weathered from shale and limestone beds. The shale layers generally are thicker than the limestone layers. They are commonly below the limestone, but the layers may be interbedded. Vanmeter soils formed in residual material.

Relief

Relief influences soil formation mostly through its effect on drainage, runoff, and erosion. The amount of water entering and passing through the soil depends on the slope, the permeability of the soil, and the amount and intensity of rainfall. Rapidly permeable soils form more slowly than slowly permeable soils in similar landscape positions. Because of rapid runoff, very little water passes through steep soils. As a result, these soils show little evidence of profile development. Runoff is slow on gently sloping and nearly level soils. Most of the water passes through these soils. The soils are characterized by maximum profile development.

Because they receive more direct sunrays, soils on steep, south-facing slopes generally are more droughty than soils that formed in similar material on north-facing slopes. Droughtiness influences soil formation through its effect on the amount and kind of vegetation, erosion, and freezing and thawing.

Time

The degree of profile development is reflected by the length of time that the parent material has been subject to weathering. Young soils show little evidence of profile development, or horizon differentiation. Old soils show the effects of clay movement and leaching. They have distinct horizons.

Alluvial soils are the youngest soils in Grundy County. Nodaway soils are characterized by no profile development because alluvial material is added to the surface nearly every year. Humeston soils are the oldest alluvial soils in the county. They are in the higher areas on the flood plains and are characterized by moderate profile development.

Gara and Shelby soils are older than the alluvial soils in the county. They formed on dissected slopes of Late Wisconsin age. They probably are 11,000 to 14,000 years old *(9)*. Grundy, Edina, Haig, and Pershing soils formed in Early Wisconsin loess, which is probably 14,000 to 16,000 years old.

Armstrong and Lamoni are the oldest soils in the county. Armstrong soils formed in weathered material of Late Sangamon age *(9)*. They are about 38,000 years old. Lamoni soils formed in material dating from the Yarmouth interglacial period *(10)*. They are more than 150,000 years old.

In some areas of the county, rocky residual material has been exposed by geologic erosion. This residuum is very old. The soils that formed in this material show little evidence of profile development, however, because of steep slopes and a moderate depth to bedrock. The moderately deep Vanmeter soils are examples.

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Glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon. Commonly, such soil formed in recent alluvium or on steep rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

Bedding planes. Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

Bedding system. A drainage system made by plowing, grading, or otherwise shaping the surface of a flat field. It consists of a series of low ridges separated by shallow, parallel dead furrows.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Channery soil. A soil that is, by volume, more than 15 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. A single piece is called a channer.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard compacted layers to a depth below normal plow depth.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushed under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons.

Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 38 centimeters) long.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock as much as 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range in moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are—

Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep-sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Similar soils. Soils that share limits of diagnostic critieria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally, it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to soil blowing and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Breaking up a compact subsoil by pulling a special chisel through the soil.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial meltwater. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-84 at Trenton, Missouri)

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January-----	33.9	14.2	24.1	60	12	0	1.07	0.23	1.72	3	6.5
February----	40.6	19.9	30.3	66	12	16	1.01	.40	1.53	3	3.4
March-------	51.1	29.1	40.1	81	1	48	2.61	1.11	3.87	6	3.4
April-------	65.4	41.8	53.6	86	22	172	3.30	1.86	4.57	7	.4
May---------	75.1	51.8	63.5	90	33	425	4.69	2.74	6.41	8	.0
June--------	83.9	61.2	72.6	97	45	678	3.97	1.88	5.77	7	.0
July--------	88.6	65.5	77.1	101	50	840	3.80	1.52	5.72	5	.0
August------	86.9	63.1	75.0	101	48	775	4.04	1.71	6.01	6	.0
September---	79.1	54.5	66.8	95	34	504	4.06	1.68	6.06	6	.0
October-----	68.3	43.9	56.1	88	23	235	2.99	.93	4.67	5	.0
November----	52.6	31.7	42.2	76	7	21	1.71	.40	2.74	3	.7
December----	39.5	20.9	30.2	66	7	13	1.54	.58	2.34	4	4.3
Yearly:											
Average----	63.8	41.5	52.6	---	---	---	---	---	---	---	---
Extreme----	---	---	---	102	7	---	---	---	---	---	---
Total------	---	---	---	---	---	3,727	34.79	28.07	41.45	63	18.7

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily tempertures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1951-84 at Trenton, Missouri)

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	Apr. 11	Apr. 22	May 4
2 years in 10 later than--	Apr. 6	Apr. 17	Apr. 29
5 years in 10 later than--	Mar. 30	Apr. 9	Apr. 20
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 20	Oct. 12	Sept. 30
2 years in 10 earlier than--	Oct. 25	Oct. 17	Oct. 5
5 years in 10 earlier than--	Nov. 4	Oct. 27	Oct. 15

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-84 at Trenton, Missouri)

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	198	183	155
8 years in 10	205	189	163
5 years in 10	218	201	178
2 years in 10	232	212	193
1 year in 10	239	219	201

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
03B	Kilwinning silt loam, 2 to 5 percent slopes	860	0.3
04	Haig silt loam	520	0.2
06	Edina silt loam	430	0.1
11B	Grundy silt loam, 2 to 5 percent slopes	11,200	4.0
12B2	Grundy silty clay loam, 2 to 5 percent slopes, eroded	12,040	4.3
14C	Lamoni loam, 5 to 9 percent slopes	6,590	2.3
15C2	Lamoni clay loam, 5 to 9 percent slopes, eroded	51,760	18.5
16D	Shelby loam, 9 to 14 percent slopes	1,270	0.4
16E	Shelby loam, 14 to 20 percent slopes	440	0.1
17D2	Shelby clay loam, 9 to 14 percent slopes, eroded	23,750	8.5
17E2	Shelby clay loam, 14 to 20 percent slopes, eroded	3,240	1.2
21D	Gara loam, 9 to 14 percent slopes	3,000	1.1
21E	Gara loam, 14 to 20 percent slopes	3,860	1.4
22D2	Gara clay loam, 9 to 14 percent slopes, eroded	17,260	6.2
22E2	Gara clay loam, 14 to 20 percent slopes, eroded	5,390	1.9
23B	Armstrong loam, 2 to 5 percent slopes	1,070	0.4
23C	Armstrong loam, 5 to 9 percent slopes	6,800	2.4
24B2	Armstrong clay loam, 2 to 5 percent slopes, eroded	870	0.3
24C2	Armstrong clay loam, 5 to 9 percent slopes, eroded	25,770	9.2
25B	Pershing silt loam, 2 to 5 percent slopes	3,910	1.4
26B2	Pershing silty clay loam, 2 to 5 percent slopes, eroded	1,790	0.6
33F	Vanmeter flaggy silty clay loam, 9 to 40 percent slopes	8,260	3.0
45	Humeston silt loam	3,080	1.1
50A	Landes fine sandy loam, 0 to 3 percent slopes	145	0.1
51	Fatima silt loam	12,030	4.3
52B	Vigar loam, 2 to 5 percent slopes	5,220	1.9
54	Zook silty clay loam	22,370	8.0
55	Colo silty clay loam	3,530	1.3
56A	Colo silty clay loam, channeled, 0 to 3 percent slopes	10,810	3.9
58	Wabash silty clay	10,830	3.9
66	Nodaway silt loam	12,820	4.6
67	Vesser silt loam	5,140	1.8
88	Pits, quarries	336	0.1
	Water	3,500	1.2
	Total	279,891	100.0

TABLE 5.--PRIME FARMLAND

(Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name)

Map symbol	Soil name
03B	Kilwinning silt loam, 2 to 5 percent slopes (where drained)
04	Haig silt loam (where drained)
06	Edina silt loam (where drained)
11B	Grundy silt loam, 2 to 5 percent slopes
12B2	Grundy silty clay loam, 2 to 5 percent slopes, eroded
23B	Armstrong loam, 2 to 5 percent slopes
24B2	Armstrong clay loam, 2 to 5 percent slopes, eroded
25B	Pershing silt loam, 2 to 5 percent slopes
26B2	Pershing silty clay loam, 2 to 5 percent slopes, eroded
45	Humeston silt loam (where drained)
50A	Landes fine sandy loam, 0 to 3 percent slopes
51	Fatima silt loam
52B	Vigar loam, 2 to 5 percent slopes
54	Zook silty clay loam (where drained)
55	Colo silty clay loam (where drained)
56A	Colo silty clay loam, channeled, 0 to 3 percent slopes (where drained)
58	Wabash silty clay (where drained)
66	Nodaway silt loam
67	Vesser silt loam (where drained)

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE

(Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Land capability	Corn	Soybeans	Grain sorghum	Winter wheat	Orchard-grass-red clover hay	Smooth brome	Switchgrass
		Bu	Bu	Bu	Bu	Tons	AUM*	AUM*
03B----------- Kilwinning	IIe	86	31	80	35	3.2	6.6	6.6
04------------ Haig	IIw	102	38	89	42	3.9	7.5	7.5
06------------ Edina	IIw	100	36	86	40	3.7	7.3	7.3
11B----------- Grundy	IIe	102	38	89	42	3.9	7.5	7.5
12B2---------- Grundy	IIIe	96	36	84	39	3.6	7.1	7.1
14C----------- Lamoni	IIIe	87	33	79	37	3.4	6.7	6.7
15C2---------- Lamoni	IIIe	82	30	73	34	3.1	6.2	6.2
16D----------- Shelby	IIIe	94	35	80	38	3.5	7.0	7.0
16E----------- Shelby	IVe	85	31	73	34	3.2	6.3	6.3
17D2---------- Shelby	IVe	89	33	78	36	3.4	6.7	6.7
17E2---------- Shelby	VIe	---	---	---	33	3.0	5.9	5.9
21D----------- Gara	IVe	86	31	75	35	3.4	6.8	6.8
21E----------- Gara	VIe	---	---	---	---	3.0	4.6	4.6
22D2---------- Gara	IVe	80	29	65	32	2.9	5.8	5.8
22E2---------- Gara	VIe	---	---	---	---	2.5	5.0	5.0
23B----------- Armstrong	IIe	85	32	77	36	3.3	6.5	6.5
23C----------- Armstrong	IIIe	83	30	73	34	3.1	6.2	6.2
24B2---------- Armstrong	IIIe	83	30	74	35	3.1	6.2	6.2
24C2---------- Armstrong	IIIe	79	29	70	32	2.9	5.8	5.8

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Grain sorghum	Winter wheat	Orchard-grass-red clover hay	Smooth brome	Switchgrass
		Bu	Bu	Bu	Bu	Tons	AUM*	AUM*
25B------------- Pershing	IIIe	92	34	81	37	3.4	6.8	6.8
26B2------------ Pershing	IIIe	87	31	76	35	3.1	6.4	6.4
33F------------- Vanmeter	VIIe	---	---	---	---	1.7	3.4	3.4
45-------------- Humeston	IIw	96	36	84	39	3.6	7.2	7.2
50A------------- Landes	IIw	75	26	68	34	2.8	4.7	4.7
51-------------- Fatima	IIw	121	45	106	49	4.5	9.0	9.0
52B------------- Vigar	IIe	121	45	106	49	4.5	9.0	9.0
54-------------- Zook	IIw	87	36	84	39	3.2	6.4	6.4
55-------------- Colo	IIw	113	41	90	42	4.2	8.4	8.4
56A------------- Colo	Vw	---	---	---	---	---	7.2	7.2
58-------------- Wabash	IIIw	81	30	71	33	2.9	6.0	6.0
66-------------- Nodaway	IIw	110	41	103	48	4.1	8.2	8.2
67-------------- Vesser	IIw	108	40	94	44	4.0	8.0	8.0
88**. Pits								

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

(Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available)

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Potential productivity: Common trees	Site index	Volume*	Trees to plant
21D------------- Gara	3A	Slight	Slight	Slight	Slight	White oak-----------	55	38	White oak, northern red oak, white ash.
						Northern red oak----	55	38	
						Hickory-------------	---	---	
21E------------- Gara	3R	Moderate	Moderate	Slight	Slight	White oak-----------	55	38	White oak, northern red oak, white ash.
						Northern red oak----	55	38	
						Hickory-------------	---	---	
22D2------------ Gara	3A	Slight	Slight	Slight	Slight	White oak-----------	55	38	White oak, northern red oak, white ash.
						Northern red oak----	55	38	
						Hickory-------------	---	---	
22E2------------ Gara	3R	Moderate	Moderate	Slight	Slight	White oak-----------	55	38	White oak, northern red oak, white ash.
						Northern red oak----	55	38	
						Hickory-------------	---	---	
23B, 23C, 24B2, 24C2----------- Armstrong	3C	Slight	Slight	Moderate	Severe	White oak-----------	55	38	Northern red oak, white ash.
						Northern red oak----	55	38	
						Hickory-------------	---	---	
25B, 26B2------- Pershing	3C	Slight	Slight	Severe	Severe	White oak-----------	55	38	White oak.
33F------------- Vanmeter	2R	Moderate	Moderate	Moderate	Severe	White oak-----------	45	30	Eastern white pine.
						Hickory-------------	---	---	
50A------------- Landes	10A	Slight	Slight	Slight	Slight	Eastern cottonwood--	105	141	Eastern cottonwood, American sycamore, green ash, black walnut.
						American sycamore---	---	---	
						Green ash-----------	---	---	
51-------------- Fatima	5A	Slight	Slight	Slight	Slight	Pin oak-------------	86	68	Pin oak, pecan, eastern cottonwood, American sycamore, black oak, black walnut.
						Black walnut--------	---	---	
						Bur oak-------------	---	---	
58-------------- Wabash	4W	Slight	Severe	Severe	Moderate	Pin oak-------------	75	57	Pin oak, pecan, eastern cottonwood.
						Silver maple--------	---	---	
						Green ash-----------	---	---	

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
66---------------- Nodaway	9A	Slight	Slight	Slight	Slight	Eastern cottonwood-- Hackberry----------- Black walnut--------	100 --- ---	128 --- ---	Black walnut, eastern cottonwood, American sycamore, green ash, white oak.

* Volume is the yield in cubic feet per acre per year calculated at the age of culmination of mean annual increment for fully stocked natural stands.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
03B Kilwinning	Lilac	Amur honeysuckle, Amur privet, American cranberrybush, arrowwood, Washington hawthorn, eastern redcedar.	Osageorange, green ash, Austrian pine.	Eastern white pine, pin oak.	---
04 Haig	---	Silky dogwood, Amur privet, Amur honeysuckle, American cranberrybush.	Norway spruce, Austrian pine, blue spruce, white fir, northern whitecedar, Washington hawthorn.	Eastern white pine	Pin oak.
06 Edina	---	Amur honeysuckle, Amur privet, American cranberrybush, silky dogwood.	Norway spruce, Austrian pine, blue spruce, northern whitecedar, white fir, Washington hawthorn.	Eastern white pine	Pin oak.
11B, 12B2 Grundy	Lilac	Washington hawthorn, eastern redcedar, Amur honeysuckle, Amur privet, American cranberrybush, arrowwood.	Austrian pine, Osageorange, green ash.	Pin oak, eastern white pine.	---
14C, 15C2 Lamoni	Lilac	Eastern redcedar, Washington hawthorn, arrowwood, Amur honeysuckle, Amur privet, American cranberrybush.	Austrian pine, green ash, Osageorange.	Eastern white pine, pin oak.	---
16D, 16E, 17D2, 17E2 Shelby	---	Silky dogwood, American cranberrybush, Amur honeysuckle, Amur privet.	Washington hawthorn, northern whitecedar, blue spruce, white fir.	Norway spruce, Austrian pine.	Pin oak, eastern white pine.
21D, 21E, 22D2, 22E2 Gara	---	Amur honeysuckle, American cranberrybush, Amur privet, silky dogwood.	Northern whitecedar, white fir, Washington hawthorn, blue spruce.	Austrian pine, Norway spruce.	Eastern white pine, pin oak.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
23B, 23C, 24B2, 24C2: Armstrong	Lilac	Eastern redcedar, Washington hawthorn, Amur privet, arrowwood, American cranberrybush, Amur honeysuckle.	Austrian pine, green ash, Osageorange.	Eastern white pine, pin oak.	---
25B, 26B2: Pershing	Lilac	Eastern redcedar, American cranberrybush, Washington hawthorn, Amur privet, Amur honeysuckle, arrowwood.	Austrian pine, Osageorange, green ash.	Eastern white pine, pin oak.	---
33F: Vanmeter	Siberian peashrub, fragrant sumac.	Eastern redcedar, Osageorange, Russian olive, Washington hawthorn.	Northern catalpa, honeylocust, green ash, black locust, bur oak.	Siberian elm	---
45: Humeston	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Norway spruce, Austrian pine, northern whitecedar, blue spruce, white fir, Washington hawthorn.	Eastern white pine	Pin oak.
50A: Landes	---	Silky dogwood, Amur privet, Amur honeysuckle, American cranberrybush.	Austrian pine, white fir, blue spruce, northern whitecedar, Washington hawthorn.	Norway spruce	Eastern white pine, pin oak.
51: Fatima	---	Amur honeysuckle, Amur privet, American cranberrybush, silky dogwood.	Austrian pine, white fir, blue spruce, northern whitecedar, Washington hawthorn.	Norway spruce	Eastern white pine, pin oak.
52B: Vigar	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Austrian pine, white fir, blue spruce, northern whitecedar, Washington hawthorn.	Norway spruce	Eastern white pine, pin oak.
54: Zook	---	Silky dogwood, Amur honeysuckle, American cranberrybush, Amur privet.	Norway spruce, northern whitecedar, Austrian pine, blue spruce, white fir, Washington hawthorn.	Eastern white pine	Pin oak.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
55. Colo	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Norway spruce, Austrian pine, blue spruce, white fir, northern whitecedar, Washington hawthorn.	Eastern white pine	Pin oak.
56A. Colo					
58. Wabash	---	Amur honeysuckle, silky dogwood, Amur privet, American cranberrybush.	Norway spruce, Austrian pine, northern whitecedar, blue spruce, white fir, Washington hawthorn.	Eastern white pine	Pin oak.
66. Nodaway	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Austrian pine, white fir, blue spruce, northern whitecedar, Washington hawthorn.	Norway spruce	Eastern white pine, pin oak.
67. Vesser	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Norway spruce, Austrian pine, northern whitecedar, blue spruce, white fir, Washington hawthorn.	Eastern white pine	Pin oak.
88*. Pits					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
03B Kilwinning	Severe: percs slowly, wetness.	Severe: percs slowly.	Severe: percs slowly, wetness.	Moderate: wetness.	Moderate: wetness.
04 Haig	Severe: wetness, percs slowly.	Severe: percs slowly.	Severe: wetness, percs slowly.	Moderate: wetness.	Moderate: wetness.
06 Edina	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.
11B, 12B2 Grundy	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Moderate: wetness.	Moderate: wetness.
14C, 15C2 Lamoni	Severe: wetness, percs slowly.	Severe: percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness.
16D Shelby	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
16E Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
17D2 Shelby	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
17E2 Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
21D Gara	Moderate: percs slowly, slope.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
21E Gara	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
22D2 Gara	Moderate: percs slowly, slope.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
22E2 Gara	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
23B Armstrong	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
23C Armstrong	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness.
24B2 Armstrong	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
24C2------------------ Armstrong	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness.
25B, 26B2------------ Pershing	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Slight----------	Slight.
33F------------------ Vanmeter	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Severe: large stones, slope, percs slowly.	Moderate: slope.	Severe: slope.
45------------------- Humeston	Severe: flooding, wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.
50A------------------ Landes	Severe: flooding.	Slight----------	Moderate: flooding.	Slight----------	Moderate: flooding.
51------------------- Fatima	Severe: flooding.	Slight----------	Moderate: flooding.	Slight----------	Moderate: flooding.
52B------------------ Vigar	Severe: flooding.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Slight----------	Slight.
54------------------- Zook	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
55------------------- Colo	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
56A------------------ Colo	Severe: flooding, wetness.	Moderate: flooding, wetness.	Severe: wetness, flooding.	Moderate: wetness, flooding.	Severe: flooding.
58------------------- Wabash	Severe: flooding, wetness, percs slowly.	Severe: wetness, too clayey, percs slowly.	Severe: too clayey, wetness.	Severe: wetness, too clayey.	Severe: wetness, too clayey.
66------------------- Nodaway	Severe: flooding.	Slight----------	Moderate: flooding.	Slight----------	Moderate: flooding.
67------------------- Vesser	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
88*. Pits					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
03B Kilwinning	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
04 Haig	Good	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
06 Edina	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
11B, 12B2 Grundy	Fair	Good	Fair	Good	Good	Fair	Fair	Fair	Good	Fair.
14C, 15C2 Lamoni	Fair	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
16D Shelby	Fair	Good	Fair	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
16E Shelby	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
17D2 Shelby	Fair	Good	Fair	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
17E2 Shelby	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
21D Gara	Fair	Good	Fair	Good	Good	Very poor.	Poor	Fair	Good	Poor.
21E Gara	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
22D2 Gara	Fair	Good	Fair	Good	Good	Very poor.	Poor	Fair	Good	Poor.
22E2 Gara	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
23B Armstrong	Fair	Good	Fair	Good	Fair	Poor	Poor	Fair	Good	Very poor.
23C Armstrong	Fair	Good	Fair	Good	Fair	Very poor.	Very poor.	Fair	Good	Very poor.
24B2 Armstrong	Fair	Good	Fair	Good	Fair	Poor	Poor	Fair	Good	Very poor.
24C2 Armstrong	Fair	Good	Fair	Good	Fair	Very poor.	Very poor.	Fair	Good	Very poor.
25B, 26B2 Pershing	Good	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
33F Vanmeter	Very poor.	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
45----------------- Humeston	Good	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
50A---------------- Landes	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
51----------------- Fatima	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
52B---------------- Vigar	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
54----------------- Zook	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
55, 56A------------ Colo	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
58----------------- Wabash	Poor	Poor	Poor	Poor	Poor	Poor	Good	Poor	Poor	Fair.
66----------------- Nodaway	Good	Good	Good	Good	Fair	Fair	Poor	Fair	Good	Fair.
67----------------- Vesser	Good	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
88*. Pits										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
03B---------------- Kilwinning	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: low strength, shrink-swell.	Moderate: wetness.
04----------------- Haig	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
06----------------- Edina	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, wetness, shrink-swell.	Severe: wetness.
11B, 12B2--------- Grundy	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
14C, 15C2--------- Lamoni	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, low strength.	Moderate: wetness.
16D---------------- Shelby	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
16E---------------- Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
17D2--------------- Shelby	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
17E2--------------- Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
21D---------------- Gara	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
21E---------------- Gara	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
22D2--------------- Gara	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
22E2--------------- Gara	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
23B, 23C, 24B2, 24C2------------- Armstrong	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: wetness, shrink-swell.	Severe: shrink-swell, wetness.	Severe: shrink-swell, low strength, frost action.	Moderate: wetness.
25B, 26B2--------- Pershing	Severe: wetness.	Severe: shrink-swell.	Severe: shrink-swell, wetness.	Severe: shrink-swell.	Severe: shrink-swell, low strength, frost action.	Slight.
33F--------------- Vanmeter	Severe: slope.	Severe: shrink-swell, slope.	Severe: slope, shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, slope, shrink-swell.	Severe: slope.
45---------------- Humeston	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, wetness, low strength.	Severe: wetness.
50A--------------- Landes	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding.
51---------------- Fatima	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.	Moderate: flooding.
52B--------------- Vigar	Severe: wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Severe: low strength, frost action.	Slight.
54---------------- Zook	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: wetness.
55---------------- Colo	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
56A--------------- Colo	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding, frost action.	Severe: flooding.
58---------------- Wabash	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: wetness, too clayey.
66---------------- Nodaway	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Moderate: flooding.
67---------------- Vesser	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.

TABLE 12.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
03B Kilwinning	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
04 Haig	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
06 Edina	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
11B, 12B2 Grundy	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness, too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack, wetness.
14C, 15C2 Lamoni	Severe: percs slowly, wetness.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
16D Shelby	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
16E Shelby	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
17D2 Shelby	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
17E2 Shelby	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
21D Gara	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
21E Gara	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
22D2 Gara	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
22E2 Gara	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
23B----------------- Armstrong	Severe: percs slowly, wetness.	Moderate: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
23C----------------- Armstrong	Severe: percs slowly, wetness.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
24B2---------------- Armstrong	Severe: percs slowly, wetness.	Moderate: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
24C2---------------- Armstrong	Severe: percs slowly, wetness.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
25B, 26B2----------- Pershing	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
33F----------------- Vanmeter	Severe: thin layer, seepage, percs slowly.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: slope.	Poor: area reclaim, hard to pack, slope.
45------------------ Humeston	Severe: wetness, percs slowly, flooding.	Severe: flooding.	Severe: wetness, too clayey, flooding.	Severe: wetness, flooding.	Poor: wetness, too clayey, hard to pack.
50A----------------- Landes	Severe: flooding, poor filter.	Severe: seepage, flooding.	Severe: flooding, seepage, too sandy.	Severe: flooding, seepage.	Poor: seepage, too sandy.
51------------------ Fatima	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
52B----------------- Vigar	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
54------------------ Zook	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
55, 56A------------- Colo	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
58------------------ Wabash	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
66------------------ Nodaway	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
67------------------ Vesser	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
88*. Pits					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
03B-------------------- Kilwinning	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
04--------------------- Haig	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
06--------------------- Edina	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
11B, 12B2------------- Grundy	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
14C-------------------- Lamoni	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
15C2------------------- Lamoni	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
16D-------------------- Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer, slope.
16E-------------------- Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
17D2------------------- Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
17E2------------------- Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
21D-------------------- Gara	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope, small stones.
21E-------------------- Gara	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
22D2------------------- Gara	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope, small stones.
22E2------------------- Gara	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
23B, 23C, 24B2, 24C2-- Armstrong	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
25B------------------ Pershing	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
26B2----------------- Pershing	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
33F------------------ Vanmeter	Poor: area reclaim, shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope, too clayey.
45------------------- Humeston	Poor: low strength, shrink-swell, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
50A------------------ Landes	Good-----------------	Probable-------------	Improbable: too sandy.	Fair: too sandy, thin layer.
51------------------- Fatima	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
52B------------------ Vigar	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
54------------------- Zook	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
55, 56A-------------- Colo	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
58------------------- Wabash	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, too clayey.
66------------------- Nodaway	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
67------------------- Vesser	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
88*. Pits				

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
03B Kilwinning	Moderate: seepage, slope.	Moderate: hard to pack, wetness.	Percs slowly, slope.	Wetness, percs slowly, slope.	Erodes easily, wetness, percs slowly.	Erodes easily, percs slowly, wetness.
04 Haig	Slight	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
06 Edina	Slight	Severe: hard to pack, wetness.	Percs slowly	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
11B, 12B2 Grundy	Moderate: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Erodes easily, wetness.	Erodes easily, percs slowly.
14C, 15C2 Lamoni	Moderate: slope.	Moderate: wetness, hard to pack.	Percs slowly, slope.	Wetness, slope.	Percs slowly, wetness.	Percs slowly, wetness.
16D, 16E, 17D2, 17E2 Shelby	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
21D, 21E, 22D2, 22E2 Gara	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
23B, 23C, 24B2, 24C2 Armstrong	Moderate: slope.	Moderate: wetness, hard to pack.	Slope, percs slowly, frost action.	Slope, wetness, percs slowly.	Percs slowly, wetness.	Percs slowly, wetness.
25B, 26B2 Pershing	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Wetness, erodes easily.	Erodes easily, percs slowly.
33F Vanmeter	Severe: slope.	Severe: hard to pack.	Deep to water	Slope, percs slowly, thin layer.	Slope, area reclaim.	Slope, area reclaim.
45 Humeston	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action, flooding.	Wetness, percs slowly. flooding.	Wetness, percs slowly.	Percs slowly, wetness.
50A Landes	Severe: seepage.	Severe: seepage, piping.	Deep to water	Flooding	Too sandy, soil blowing.	Favorable.
51 Fatima	Moderate: seepage.	Moderate: thin layer, piping, wetness.	Deep to water	Flooding	Favorable	Favorable.
52B Vigar	Moderate: slope.	Moderate: wetness.	Frost action, slope.	Wetness, slope.	Wetness	Favorable.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
54: Zook	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
55, 56A: Colo	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Wetness, flooding.	Wetness	Wetness.
58: Wabash	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding.	Wetness, droughty, slow intake.	Wetness, percs slowly.	Wetness, droughty, percs slowly.
66: Nodaway	Moderate: seepage.	Severe: piping.	Deep to water	Flooding, erodes easily.	Erodes easily	Erodes easily.
67: Vesser	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Wetness, flooding.	Erodes easily, wetness.	Wetness, erodes easily.
88*. Pits						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
03B---------------- Kilwinning	0-8	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	100	95-100	90-100	25-40	5-15
	8-26	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	90-100	55-70	35-45
	26-43	Silty clay loam, silty clay.	CL, CH	A-7	0	100	100	95-100	90-100	40-55	20-30
	43-60	Silt loam, silty clay loam.	CL	A-6	0	100	100	90-100	80-100	25-35	11-20
04---------------- Haig	0-9	Silt loam--------	CL	A-6, A-7	0	100	100	100	95-100	35-45	15-25
	9-13	Silty clay loam, silty clay.	CL, CH	A-7	0	100	100	100	95-100	40-55	20-30
	13-48	Silty clay-------	CH	A-7	0	100	100	100	95-100	50-65	30-40
	48-60	Silty clay loam	CL, CH	A-7, A-6	0	100	100	100	95-100	35-55	20-30
06---------------- Edina	0-17	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	100	95-100	85-100	25-40	5-15
	17-50	Silty clay-------	CH	A-7	0	100	100	95-100	90-100	55-75	30-45
	50-60	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	90-100	35-60	15-35
11B--------------- Grundy	0-11	Silt loam--------	CL	A-6, A-7	0	100	100	95-100	90-100	30-45	10-20
	11-16	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	95-100	90-100	45-55	25-35
	16-32	Silty clay-------	CH	A-7	0	100	100	95-100	90-100	50-70	30-45
	32-60	Silty clay loam	CH, CL	A-7	0	100	100	90-100	90-100	40-55	25-35
12B2-------------- Grundy	0-8	Silty clay loam	CH, CL	A-7	0	100	100	95-100	90-100	40-55	20-35
	8-36	Silty clay-------	CH	A-7	0	100	100	95-100	90-100	50-70	30-45
	36-60	Silty clay loam	CH, CL	A-7	0	100	100	90-100	90-100	40-55	25-35
14C--------------- Lamoni	0-8	Loam-------------	CL	A-6	0	95-100	95-100	80-95	70-95	25-40	10-20
	8-60	Clay loam, clay	CH	A-7	0	95-100	95-100	90-100	85-100	50-60	25-35
15C2-------------- Lamoni	0-6	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	80-95	70-95	35-45	15-25
	6-54	Clay loam, clay	CH	A-7	0	95-100	95-100	90-100	85-100	50-60	25-35
	54-60	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	70-90	55-85	35-50	15-30
16D, 16E---------- Shelby	0-7	Loam-------------	CL	A-6	0	95-100	85-95	75-90	55-70	30-40	10-20
	7-37	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	37-60	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
17D2, 17E2-------- Shelby	0-6	Clay loam--------	CL	A-6, A-7	0	90-95	85-95	75-90	55-70	35-45	15-25
	6-31	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	31-60	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
21D, 21E---------- Gara	0-10	Loam-------------	CL, CL-ML	A-4, A-6	0	95-100	85-95	75-85	55-70	20-30	5-15
	10-36	Clay loam, loam	CL	A-6	0-5	90-95	85-95	70-85	55-75	30-40	15-25
	36-60	Loam, clay loam	CL	A-6, A-7	0-5	90-95	85-95	70-85	55-75	35-45	15-25
22D2, 22E2-------- Gara	0-6	Clay loam--------	CL	A-6, A-7	0	90-95	85-95	70-85	55-75	35-45	15-25
	6-36	Clay loam, loam	CL	A-6	0-5	90-95	85-95	70-85	55-75	30-40	15-25
	36-60	Loam, clay loam	CL	A-6, A-7	0-5	90-95	85-95	70-85	55-75	35-45	15-25
23B, 23C---------- Armstrong	0-11	Loam-------------	CL, CL-ML	A-6, A-4	0-5	90-100	80-95	75-90	55-80	20-30	5-15
	11-42	Clay loam, clay, silty clay loam.	CL, CH, ML, MH	A-7	0-5	90-100	80-95	70-90	55-80	45-70	20-35
	42-60	Clay loam--------	CL	A-6	0-5	90-100	80-95	70-90	55-80	30-40	15-20
24B2, 24C2-------- Armstrong	0-6	Clay loam--------	CL	A-6, A-7	0-5	90-100	80-95	75-90	55-80	35-45	15-25
	6-54	Clay loam, clay, silty clay loam.	CL, CH, ML, MH	A-7	0-5	90-100	80-95	70-90	55-80	45-70	20-35
	54-60	Clay loam--------	CL	A-6	0-5	90-100	80-95	70-90	55-80	30-40	15-20

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag-ments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas-ticity index
	In				Pct					Pct	
25B------------- Pershing	0-13	Silt loam--------	CL	A-6	0	100	100	100	95-100	30-40	10-20
	13-19	Silty clay loam	CL, CH	A-7	0	100	100	100	95-100	40-55	15-30
	19-42	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	100	95-100	40-65	20-40
	42-60	Silty clay loam, silt loam.	CH, CL	A-7, A-6	0	100	100	100	95-100	35-55	20-35
26B2------------ Pershing	0-7	Silty clay loam	CL, CH	A-7	0	100	100	100	95-100	40-55	15-30
	7-12	Silty clay loam	CL, CH	A-7	0	100	100	100	95-100	40-55	15-30
	12-43	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	100	95-100	40-65	20-40
	43-60	Silty clay loam, silt loam.	CH, CL	A-7, A-6	0	100	100	100	95-100	35-55	20-35
33F------------- Vanmeter	0-6	Flaggy silty clay loam.	CL-ML, CL	A-4, A-6, A-7	5-15	95-100	75-100	70-100	65-100	25-45	5-20
	6-32	Silty clay, clay	CH, CL	A-7	0-5	95-100	75-100	70-100	65-100	40-65	24-40
	32-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
45-------------- Humeston	0-13	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	95-100	95-100	25-40	5-15
	13-20	Silt loam--------	CL, CL-ML	A-6, A-4	0	100	100	95-100	95-100	25-40	5-15
	20-60	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	95-100	95-100	45-55	25-35
50A------------- Landes	0-21	Fine sandy loam	SM, SC, SM-SC	A-4, A-2-4	0	100	70-100	70-95	20-50	<25	NP-10
	21-32	Loam, very fine sandy loam, loamy fine sand.	SM, CL-ML, SC, SM-SC	A-4, A-2-4	0	100	85-100	70-100	15-60	<25	NP-10
	32-60	Stratified sand to silt loam.	SM, SP-SM, SC, SM-SC	A-4, A-2-4	0	100	85-100	70-85	10-50	<30	NP-10
51-------------- Fatima	0-14	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	100	95-100	85-100	25-40	5-18
	14-55	Silt loam--------	CL	A-6	0	100	100	95-100	90-100	30-40	12-18
	55-68	Silt loam, loam	CL-ML, CL	A-4, A-6	0	100	100	95-100	85-100	25-40	5-18
52B------------- Vigar	0-30	Loam-------------	CL-ML, CL	A-4, A-6	0	95-100	90-100	85-95	60-75	20-30	5-15
	30-74	Clay loam, silty clay loam.	CL	A-6	0	95-100	90-100	80-95	70-90	30-40	15-25
54-------------- Zook	0-15	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	45-65	20-35
	15-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	35-55
55-------------- Colo	0-14	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	14-60	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
56A------------- Colo	0-15	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	15-60	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
58-------------- Wabash	0-18	Silty clay-------	CH	A-7	0	100	100	100	95-100	50-75	30-50
	18-60	Silty clay, clay	CH	A-7	0	100	100	100	95-100	52-78	30-55
66-------------- Nodaway	0-9	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-35	5-15
	9-60	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-40	5-15
67-------------- Vesser	0-15	Silt loam--------	CL	A-6	0	100	100	98-100	95-100	30-40	10-20
	15-28	Silt loam--------	CL	A-6	0	100	100	98-100	95-100	30-40	10-20
	28-60	Silty clay loam	CL	A-7	0	100	100	98-100	95-100	40-50	15-25

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
03B-------------- Kilwinning	0-8	15-27	1.35-1.50	0.6-2.0	0.22-0.24	5.6-7.3	Low----------	0.37	3	6	2-4
	8-26	35-55	1.30-1.40	<0.06	0.11-0.13	4.5-6.0	High---------	0.37			
	26-43	35-55	1.30-1.40	0.06-0.2	0.18-0.20	5.6-7.3	Moderate-----	0.37			
	43-60	25-35	1.30-1.40	0.6-2.0	0.20-0.22	6.6-7.8	Low----------	0.37			
04--------------- Haig	0-9	22-27	1.35-1.40	0.6-2.0	0.22-0.24	5.6-7.3	Moderate-----	0.37	3	6	3-4
	9-13	28-48	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.0	High---------	0.37			
	13-48	40-50	1.30-1.45	<0.06	0.12-0.14	5.1-6.0	High---------	0.37			
	48-60	28-40	1.40-1.50	0.2-0.6	0.18-0.20	6.1-7.3	High---------	0.37			
06--------------- Edina	0-17	15-27	1.35-1.45	0.6-2.0	0.22-0.24	5.1-7.3	Moderate-----	0.37	3	6	1-4
	17-50	45-60	1.30-1.45	<0.06	0.11-0.13	5.6-7.3	Very high----	0.37			
	50-60	27-40	1.35-1.50	0.06-0.2	0.18-0.20	6.6-7.3	High---------	0.37			
11B-------------- Grundy	0-11	12-27	1.35-1.50	0.6-2.0	0.22-0.24	5.6-7.3	Moderate-----	0.37	3	6	2-4
	11-16	32-45	1.35-1.45	0.2-0.6	0.18-0.20	5.6-6.5	High---------	0.37			
	16-32	40-50	1.30-1.40	0.06-0.2	0.11-0.13	5.1-7.3	High---------	0.37			
	32-60	28-35	1.35-1.40	0.06-0.2	0.18-0.20	5.6-7.3	High---------	0.37			
12B2------------- Grundy	0-8	28-35	1.35-1.45	0.2-0.6	0.18-0.20	5.6-7.3	High---------	0.37	3	7	2-4
	8-36	40-50	1.30-1.40	0.06-0.2	0.11-0.13	5.1-7.3	High---------	0.37			
	36-60	28-35	1.35-1.40	0.06-0.2	0.18-0.20	5.6-7.3	High---------	0.37			
14C-------------- Lamoni	0-8	22-27	1.40-1.45	0.2-0.6	0.17-0.21	5.1-7.3	Moderate-----	0.32	3	6	3-4
	8-60	38-50	1.55-1.65	0.06-0.2	0.13-0.17	5.1-6.5	High---------	0.32			
15C2------------- Lamoni	0-6	27-40	1.45-1.50	0.2-0.6	0.17-0.21	5.1-7.3	Moderate-----	0.32	3	6	2-3
	6-54	38-50	1.55-1.65	0.06-0.2	0.13-0.17	5.1-6.5	High---------	0.32			
	54-60	32-40	1.60-1.70	0.06-0.2	0.14-0.18	5.6-7.3	High---------	0.32			
16D, 16E--------- Shelby	0-7	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.1-7.3	Moderate-----	0.28	5	6	3-4
	7-37	30-35	1.55-1.65	0.2-0.6	0.16-0.18	5.1-7.3	Moderate-----	0.28			
	37-60	30-35	1.55-1.65	0.2-0.6	0.16-0.18	6.6-8.4	Moderate-----	0.37			
17D2, 17E2------- Shelby	0-6	27-35	1.50-1.55	0.2-0.6	0.16-0.18	5.1-7.3	Moderate-----	0.28	5	6	2-3
	6-31	30-35	1.55-1.65	0.2-0.6	0.16-0.18	5.1-7.3	Moderate-----	0.28			
	31-60	30-35	1.55-1.65	0.2-0.6	0.16-0.18	6.6-8.4	Moderate-----	0.37			
21D, 21E--------- Gara	0-10	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.28	5	6	2-3
	10-36	25-38	1.55-1.75	0.2-0.6	0.16-0.18	4.5-6.5	Moderate-----	0.28			
	36-60	24-38	1.65-1.75	0.2-0.6	0.16-0.18	6.6-8.4	Moderate-----	0.37			
22D2, 22E2------- Gara	0-6	27-35	1.50-1.55	0.2-0.6	0.16-0.18	5.6-7.3	Moderate-----	0.28	5	6	1-2
	6-36	25-38	1.55-1.75	0.2-0.6	0.16-0.18	4.5-6.5	Moderate-----	0.28			
	36-60	24-38	1.65-1.75	0.2-0.6	0.16-0.18	6.6-8.4	Moderate-----	0.37			
23B, 23C--------- Armstrong	0-11	22-27	1.45-1.50	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.32	3	6	2-3
	11-42	36-60	1.45-1.55	0.06-0.2	0.11-0.16	4.5-6.5	High---------	0.32			
	42-60	30-36	1.55-1.70	0.2-0.6	0.14-0.16	5.1-7.3	Moderate-----	0.32			
24B2, 24C2------- Armstrong	0-6	35-42	1.45-1.50	0.2-0.6	0.18-0.20	5.6-7.3	Moderate-----	0.32	3-2	4	1-2
	6-54	36-60	1.45-1.55	0.06-0.2	0.11-0.16	4.5-6.5	High---------	0.32			
	54-60	30-36	1.55-1.70	0.2-0.6	0.14-0.16	5.1-7.3	Moderate-----	0.32			
25B-------------- Pershing	0-13	20-27	1.30-1.40	0.6-2.0	0.22-0.24	4.5-7.3	Low----------	0.37	3-2	6	2-3
	13-19	27-35	1.30-1.40	0.2-0.6	0.20-0.22	5.1-6.0	Moderate-----	0.37			
	19-42	35-48	1.35-1.45	0.06-0.2	0.18-0.20	5.1-6.0	High---------	0.37			
	42-60	24-40	1.35-1.50	0.2-0.6	0.18-0.20	5.1-6.5	High---------	0.37			

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
26B2------------- Pershing	0-7	27-38	1.30-1.40	0.2-0.6	0.22-0.24	4.5-7.3	Moderate-----	0.37	3-2	7	1-2
	7-12	27-35	1.30-1.40	0.2-0.6	0.20-0.22	5.1-6.0	Moderate-----	0.37			
	12-43	35-48	1.35-1.45	0.06-0.2	0.18-0.20	5.1-6.0	High---------	0.37			
	43-60	24-40	1.35-1.50	0.2-0.6	0.18-0.20	5.1-6.5	High---------	0.37			
33F-------------- Vanmeter	0-6	24-35	1.35-1.50	0.2-0.6	0.14-0.16	6.1-8.4	Moderate-----	0.32	3	8	1-2
	6-32	40-60	1.50-1.60	<0.06	0.12-0.14	6.1-8.4	High---------	0.32			
	32-60	---	---	---	---	---	-------------	-----			
45--------------- Humeston	0-13	24-27	1.35-1.40	0.6-2.0	0.21-0.23	5.1-7.3	Low----------	0.32	4	6	3-4
	13-20	20-26	1.30-1.35	0.2-2.0	0.20-0.22	4.5-6.0	Moderate-----	0.32			
	20-60	30-48	1.35-1.50	<0.06	0.13-0.15	4.5-6.5	High---------	0.32			
50A-------------- Landes	0-21	7-20	1.40-1.60	2.0-6.0	0.13-0.20	6.1-8.4	Low----------	0.20	4	3	1-2
	21-32	5-18	1.60-1.70	2.0-6.0	0.10-0.15	6.1-8.4	Low----------	0.32			
	32-60	5-18	1.60-1.80	6.0-20	0.05-0.15	6.1-8.4	Low----------	0.20			
51--------------- Fatima	0-14	15-27	1.30-1.45	0.6-2.0	0.22-0.24	6.1-7.3	Low----------	0.28	5	6	2-4
	14-55	18-27	1.35-1.55	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.28			
	55-68	18-27	1.35-1.55	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.28			
52B-------------- Vigar	0-30	15-27	1.25-1.45	0.6-2.0	0.20-0.22	5.6-6.5	Low----------	0.24	5	5	2-4
	30-74	27-35	1.20-1.40	0.2-0.6	0.14-0.16	5.6-7.3	Moderate-----	0.32			
54--------------- Zook	0-15	35-40	1.30-1.35	0.2-0.6	0.21-0.23	5.6-7.3	High---------	0.28	5	7	5-7
	15-60	36-45	1.30-1.45	0.06-0.2	0.11-0.13	5.6-7.8	High---------	0.28			
55--------------- Colo	0-14	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.28	5	7	5-7
	14-60	30-35	1.25-1.35	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.28			
56A-------------- Colo	0-15	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.28	5	7	5-7
	15-60	30-35	1.25-1.35	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.28			
58--------------- Wabash	0-18	40-46	1.25-1.45	<0.06	0.12-0.14	5.6-7.3	Very high----	0.28	5	4	2-4
	18-60	40-60	1.20-1.45	<0.06	0.08-0.12	5.6-7.8	Very high----	0.28			
66--------------- Nodaway	0-9	18-27	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	Low----------	0.37	5	6	2-3
	9-60	18-28	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	Moderate-----	0.37			
67--------------- Vesser	0-15	20-26	1.30-1.35	0.6-2.0	0.20-0.24	5.6-7.3	Moderate-----	0.32	5	6	3-4
	15-28	18-22	1.35-1.40	0.6-2.0	0.18-0.22	5.1-6.0	Moderate-----	0.43			
	28-60	30-35	1.40-1.45	0.6-2.0	0.17-0.21	5.1-6.5	Moderate-----	0.43			
88*. Pits											

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
03B--------------- Kilwinning	D	None---------	---	---	1.0-2.0	Perched	Nov-Apr	>60	---	Moderate	High-----	Moderate.
04---------------- Haig	C/D	None---------	---	---	1.0-2.0	Apparent	Nov-Apr	>60	---	High-----	High-----	Moderate.
06---------------- Edina	D	None---------	---	---	0.5-2.0	Perched	Nov-Apr	>60	---	Moderate	High-----	Moderate.
11B, 12B2--------- Grundy	C	None---------	---	---	1.5-3.0	Perched	Nov-Apr	>60	---	High-----	High-----	Moderate.
14C, 15C2--------- Lamoni	C	None---------	---	---	1.0-3.0	Perched	Nov-Apr	>60	---	Moderate	High-----	Moderate.
16D, 16E, 17D2, 17E2-------------- Shelby	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
21D, 21E, 22D2, 22E2------------- Gara	C	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
23B, 23C, 24B2, 24C2------------- Armstrong	C	None---------	---	---	1.0-3.0	Perched	Nov-Apr	>60	---	High-----	High-----	Moderate.
25B, 26B2--------- Pershing	C	None---------	---	---	2.0-4.0	Perched	Nov-Apr	>60	---	High-----	High-----	Moderate.
33F--------------- Vanmeter	C	None---------	---	---	>6.0	---	---	20-40	Soft	Moderate	High-----	Low.
45---------------- Humeston	C/D	Occasional	Very brief	Nov-Apr	0-1.0	Apparent	Nov-Apr	>60	---	High-----	High-----	Moderate.
50A--------------- Landes	B	Occasional	Brief-----	Nov-Apr	>6.0	---	---	>60	---	Moderate	Low------	Low.
51---------------- Fatima	B	Occasional	Brief-----	Nov-Apr	3.0-5.0	Apparent	Nov-Apr	>60	---	High-----	Moderate	Low.
52B--------------- Vigar	C	Rare---------	---	---	2.0-3.0	Apparent	Nov-Apr	>60	---	High-----	High-----	Moderate.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
54----------------- Zook	C/D	Occasional	Brief to long.	Nov-Apr	0-3.0	Apparent	Nov-Apr	>60	---	High-----	High-----	Moderate.
55----------------- Colo	B/D	Occasional	Very brief to long.	Nov-Apr	1.0-3.0	Apparent	Nov-Apr	>60	---	High-----	High-----	Moderate.
56A---------------- Colo	B/D	Frequent----	Very brief or brief.	Nov-Apr	1.0-3.0	Apparent	Nov-Apr	>60	---	High-----	High-----	Moderate.
58----------------- Wabash	D	Occasional	Brief to long.	Nov-Apr	0-1.0	Apparent	Nov-Apr	>60	---	Moderate	High-----	Moderate.
66----------------- Nodaway	B	Occasional	Very brief to brief.	Nov-Apr	3.0-5.0	Apparent	Nov-Apr	>60	---	High-----	Moderate	Low.
67----------------- Vesser	C	Occasional	Brief-----	Nov-Apr	1.0-3.0	Apparent	Nov-Apr	>60	---	High-----	High-----	Moderate.
88*. Pits												

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Armstrong	Fine, montmorillonitic, mesic Aquollic Hapludalfs
Colo	Fine-silty, mixed, mesic Cumulic Haplaquolls
Edina	Fine, montmorillonitic, mesic Typic Argialbolls
Fatima	Fine-silty, mixed, mesic Fluvaquentic Hapludolls
Gara	Fine-loamy, mixed, mesic Mollic Hapludalfs
Grundy	Fine, montmorillonitic, mesic Aquic Argiudolls
Haig	Fine, montmorillonitic, mesic Typic Argiaquolls
Humeston	Fine, montmorillonitic, mesic Argiaquic Argialbolls
Kilwinning	Fine, montmorillonitic, mesic Vertic Ochraqualfs
Lamoni	Fine, montmorillonitic, mesic Aquic Argiudolls
Landes	Coarse-loamy, mixed, mesic Fluventic Hapludolls
Nodaway	Fine-silty, mixed, nonacid, mesic Mollic Udifluvents
Pershing	Fine, montmorillonitic, mesic Aquollic Hapludalfs
Shelby	Fine-loamy, mixed, mesic Typic Argiudolls
Vanmeter	Fine, illitic, mesic Typic Eutrochrepts
Vesser	Fine-silty, mixed, mesic Argiaquic Argialbolls
Vigar	Fine-loamy, mixed, mesic Aquic Argiudolls
Wabash	Fine, montmorillonitic, mesic Vertic Haplaquolls
Zook	Fine, montmorillonitic, mesic Cumulic Haplaquolls

Accessibility Statement